United States Department of Agriculture Forest Service

Ione Ecological Restoration Project

Newport-Sullivan Lake Ranger Districts

Colville National Forest

Silviculture and Fuels Resource Report

Prepared by:

Jerry Bednarczyk and Katharine Napier
Silviculturists

J. Cody Montgomery
Fuels Specialist

April 2021

Table of Contents

Tables

1.0 Introduction

The silviculture and fuels report summarizes the potential effects on forest vegetation structure, health, and growth, and fire processes from proposed actions in the Ione analysis area. This assessment addresses how the proposed action impacts the existing conditions of vegetation within the project area.

The effects to vegetation by the proposed actions are directly related to the purpose and need of the project.

2.0 Relevant Laws, Regulations, and Policy

All resource management activities described and proposed for this project are consistent with applicable Federal law, USDA regulations, Forest Service policies, and applicable provisions of state law.

2.1 Land Management Plan

The 2019 Colville National Forest Land Management Plan (LMP), informally known as the forest plan, guides all natural resource management activities and establishes standards and guidelines for the Colville National Forest.

2.1.1 Forestwide Desired Conditions, Standards and Guidelines

The following forestwide desired conditions, standards and guidelines from (LMP, Chapter 2, Pages 29-42) were followed when developing the Proposed Action.

2.1.1.1 Desired Conditions

The desired future conditions from the LMP that are relevant to this project include:

FW-DC-AIR-01. Air Quality Protection

Air quality on National Forest System lands is protected, maintained and/or improved at the Forest scale over the life of the Plan. Management activities contribute to conditions that meet or exceed National Ambient Air Quality Standards on the Forest.

Forest visitors and/or residents living adjacent to the national forest experience clean air and clear views as would occur under natural conditions. They are aware of short-term impacts to air quality due to wildland fires and prescribed burns.

FW-DC-VEG-01. Plant Species Composition

Native species and native plant communities are the desired dominant vegetation. National Forest System lands contribute to the diversity, species composition, and structural diversity of native upland plant communities. The full range of potential natural vegetation is maintained on the Forest where it supports plant and animal diversity including pollinators and other invertebrates, and robust ecological function.

FW-DC-VEG-02. Insects and Diseases

Native insects, diseases, fungi, bacteria, and viruses engage in their natural (endemic) role in contributing to ecosystem processes such as pollination, food webs, decay and nutrient cycling, providing habitats, and functioning as natural control agents. Landscapes provide a patchwork of varied structural, compositional, and successional stages that ensure the continuation of these processes.

FW-DC-VEG-03. Forest Structure

Forest structural classes are resilient and compatible with maintaining characteristic disturbance processes such as wildland fire, insects, and diseases. Habitat conditions for associated species are present. Structure contributes to scenic quality and contributes to desired landscape character, particularly along scenic byways and highways. Forest openings would be commensurate with historical conditions for size and distribution to reflect natural disturbance processes. The historical range of variability for forest structure is the desired condition. Historical range of variability will be evaluated on National Forest System lands at the appropriate scale, given vegetation type and natural disturbance history. Tables 5 and 6 contain desired conditions for each vegetation type.

FW-DC-VEG-04. Snags and Coarse Woody Debris

Snags and down wood occur in sizes, amounts, and distributions to provide important wildlife habitat and contribute to ecosystem processes and services. This desired condition for snag and down wood levels applies forestwide within forested habitat types with the exception of the Administrative and Recreation Sites Management Areas. The desired conditions for snags and down wood levels are evaluated on National Forest system lands at the watershed scale (see Tables 7 and 8).

FW-DC-VEG-05. Biological Legacies

Large trees, snags, and down wood are represented across the landscape and large tree habitat is maintained to support wildlife, aquatic and soil resources and support recovery processes in the post disturbance ecosystem.

Examples of biological legacy categories are provided in Table 9. Not all components will be present within an individual site-specific project area.

FW-DC-VEG-06. Native Plant Materials

Locally collected native plant materials are incorporated into project planning and implementation when restoration, rehabilitation, and revegetation goals support ecosystem integrity and resilience. Locally adapted plant material inventories are maintained to provide for revegetation project needs.

FW-DC-VEG-07. Native Plant Seeds and Other Genetic Material

Seeds and genetic material from native vascular and non-vascular plants are available for the purposes of genetic or trait testing, climate change provenance trials, species identification, restoration, or rehabilitation activities. Seeds and other genetic materials are stored in both secure off-site facilities and on-site in existing seed orchards, select trees, evaluation plantations, and other established genetic resource test sites.

FW-DC-VEG-08. Threatened, Endangered and Sensitive Plant Species − Special and Unique Habitats

Special and unique habitats support threatened, endangered, and sensitive plant species populations and contribute to high quality suitable habitat for these species. Degraded or diminished special and unique habitats are restored within their natural range of variation.

FW-DC-VEG-09. Threatened, Endangered and Sensitive Plant Species − Management-Related Disturbance

Ecological conditions and processes that sustain the habitats currently or potentially occupied by threatened, endangered, or sensitive plant species are retained or restored. The geographic distributions of sensitive plant species in the Forest Plan area are maintained. This includes sufficient seed or vegetative reproduction to maintain existing plant populations and associated native plant community biodiversity.

Soil disturbance is managed to avoid degradation of threatened, endangered and sensitive plant species and their habitat as well as plant community composition, structure, and productivity.

FW-DC-VEG-10. Threatened, Endangered and Sensitive Plant Species − Habitat and Population Trends

Population trends, amount of occupied habitat, and amount of unoccupied suitable habitat are stable or increasing for threatened, endangered, and sensitive plant species.

FW-DC-VEG-11. Fuels Treatments in Wildland-urban Interface

Fuel treatments continue to reduce surface, ladder, and crown fuels that lower the potential for high-severity wildfires in wildland-urban interface areas, providing protection for communities and diversity within the stands. Generally, treated areas consist of open understories with overstory trees (conifers and hardwoods) populated by predominately fire resistant species, with scattered individual or small patches of shrubs and small trees in the understory, maintaining some cover in important wildlife corridors. Surface, ladder, and crown fuels have been treated and maintained to allow low-intensity surface wildland fires (flame lengths of 4 feet or less). Vegetation has been modified (interrupted) to improve community protection and enhance public and firefighter safety.

Crown base heights (height from the forest floor to the bottom most branches of the live tree crown) are managed to avoid crown fires. Crown cover of forest stands allow for adequate spacing between crowns to reduce crown fire potential while minimizing effects on surface wind speeds and drying of surface fuels.

FW-DC-VEG-12. Snags and Coarse Woody Debris in Wildland-urban Interface

Snag levels would follow desired conditions for snags within the specific vegetation type unless there are site-specific safety concerns (for example, within 1.5 to 2 tree lengths of structures). Coarse woody debris levels would generally be at the lower end of desired conditions for the specific vegetation type to reduce fuel load and wildfire risk.

FW-DC-VEG-13. Treatment Priorities in Wildland-urban Interface

Fuel treatments are emphasized in wildland-urban interface and areas that exhibit the potential for high-severity fire behavior that could impact private or other agency lands.

FW-DC-VEG-14. Maintenance in Wildland-urban Interface

A pattern of treatments that are effective in modifying fire behavior, as identified in individual community wildfire protection plans, are established and maintained.

2.1.1.2 Standards

FW-STD-AIR-01. Air Quality

Activities comply with the national standards set forth in the Clean Air Act, and any State and local requirements for air pollution control. Planned ignitions shall follow all Washington State smoke regulations to reduce the potential impacts of smoke.

FW-STD-VEG-01. Wildland Fire Protection of Natural Resources and Property

Protect human life as the single, overriding priority. Set priorities among protecting human communities and community infrastructure, other property and improvements, and natural and cultural resources based on the values to be protected, human health and safety, and the costs of protection. Once people have been committed to an incident, the highest value to be protected is human resources. After protection of human life, all other protection decisions are to be made based on values to be protected, human health and safety, and the costs of protection.

FW-STD-VEG-03. Timber Production

Regulated timber harvest activities shall occur only on those lands classified as suitable for timber production (see suitability tables in chapter 3). Timber harvest on lands not suitable for timber production shall occur only to meet multiple-use purposes other than timber production.

FW-STD-VEG-04. Even-Aged Harvest Openings

If individual harvest openings created by even-aged silvicultural practices are proposed that would exceed 40 acres, then NFMA requirements regarding public notification and approval shall be followed. These opening size limits shall not apply to the size of areas harvested as a result of natural catastrophic conditions such as fire, insect and disease attack, or windstorm.

FW-STD-VEG-05. Restocking

Ensure that timber will be harvested from National Forest System lands only where there is assurance that such lands can be adequately restocked within 5 years after harvest. Restocking level is prescribed in a site-specific silviculture prescription for a project treatment unit and is determined to be adequate depending on the objectives and desired conditions for the Plan area.

FW-STD-VEG-06. Even-aged Management

Even-aged stands shall generally have reached or surpassed culmination of mean annual increment prior to regeneration harvest. This shall not preclude the use of sound silvicultural practices, such as thinning or other stand improvement measures, or salvage or sanitation harvesting of timber stands that are substantially damaged by fire, windthrow or other catastrophe, or that are in imminent danger from insect or disease attack.

FW-STD-VEG-07. Even-aged Management

Ensure that clearcutting, seed tree cutting, shelterwood cutting, and other cuts designed to regenerate an even-aged stand of timber will be used as a cutting method on National Forest System lands only where for clearcutting, it is determined to be the optimum method, and for other such cuts it is determined to be appropriate to meet the objectives and requirements of the Forest Plan.

FW-STD-VEG-08. Harvest Systems

The harvesting system to be used shall not be selected primarily because it will give the greatest dollar return or the greatest unit output of timber.

FW-STD-VEG-09. Timber Harvest

Ensure that timber will be harvested from National Forest System lands only where soil, slope, or other watershed conditions will not be irreversibly damaged and where protection is provided for streams, streambanks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperature, blockage of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat.

2.1.1.3 Guidelines

FW-GDL-VEG-01. Threatened, Endangered, and Sensitive Plant Species – Disturbance in Occupied Habitat

Soil and habitat disturbance should be managed within occupied habitat and suitable whitebark pine habitat to the extent practicable to maintain or enhance threatened, endangered, and sensitive plant populations and avoid invasive plant species establishment or spread. Consequently, occupied habitat should not be used for timber harvest, fuel breaks or developments associated with wildfire suppression, delivery of fire retardant or petroleum products, placement of stock-handling facilities, recreation, or special use developments. A 100-foot buffer between the occupied habitat and these management activities should be maintained, unless habitat restoration activities are designed to benefit threatened, endangered, and sensitive plant species.

Trees in occupied habitat that are felled for safety reasons should be retained on site as needed to maintain, protect, or enhance habitat unless such action is detrimental to the threatened, endangered, and sensitive species population or habitat and represents a threat through physical impacts or potential uncharacteristic wildfire.

All new road and trail construction should be designed to avoid the occupied habitat of threatened, endangered, and sensitive plant species (minimum 100-foot buffer).

Use of prescribed fire should be avoided in occupied habitat except in areas occupied by fire-dependent or fire-tolerant species. Slash piles and other fuels should be managed to avoid the occupied habitat of threatened, endangered, and sensitive species (minimum 100-foot buffer).

FW-GDL-VEG-02. Plant Material Collection for Conservation Purposes

Commercial or non-commercial permits or authorizations should generally be issued for collection of seed or plant materials when project objectives are consistent with rare species conservation practices (these practices could include seed storage in recognized seed banks, or collection of plant material for restoration and rehabilitation purposes, or scientific research that benefits species viability).

FW-GDL-VEG-03. Large Tree Management

Management activities should retain and generally emphasize recruitment of individual large trees (larger than 20 inches diameter at breast height) across the landscape. Exceptions where individual large trees may be removed or destroyed include the following:

- Trees need to be removed for public health or safety (such as, but not limited to, danger/hazard trees along roads or in developed or administrative sites).
- Trees need to be removed to facilitate management of emergency situations such as wildfire response.

The following exemptions apply only to situations where removal of smaller trees alone cannot achieve the stated desired conditions:

- Trees need to be removed to meet, promote, or maintain desired conditions for structural stages (see FW-DC-VEG-03. Forest Structure).
- Trees need to be removed to control or limit the spread of insect infestation or disease.
- Trees need to be removed where strategically critical to reinforce, facilitate, or improve effectiveness of fuel reduction in wildland-urban interfaces.
- Trees need to be removed to promote special plant habitats (such as, but not limited to, aspen, cottonwood, whitebark pine).

FW-GDL-VEG-04. Planned and Unplanned Ignitions

Use of planned and management of unplanned ignitions may be authorized. Objectives and strategies for all unplanned ignitions shall be identified at the time of the fire.

2.1.1.4 Management Area Desired Conditions

General Restoration (GR) Areas

MA-DC-GR-01. Vegetation

The landscape is predominantly natural-appearing to slightly altered to moderately altered, and contributes to the variety of native plant communities and the composition, structure, and patterns as defined in desired conditions for vegetative systems, aquatic, plant, and wildlife habitats. The desired conditions for vegetation are achieved through a combination of ecological processes and management activities. While the landscape is natural-appearing, there are locations that have a vegetation composition, structure, or pattern that is altered to provide a recreational setting such as openings maintained for scenic views; or other desired conditions, such as vegetation fuel conditions adjacent to an urban interface. The scenic integrity objectives would range from low to high.

Focused Restoration (FR) Areas

MA-DC-FR-01. Vegetation

The landscape contributes to the variety of native plant communities and the composition, structure, and patterns as defined in desired conditions for vegetative systems, aquatic, plant, and wildlife habitats. The desired conditions for vegetation are achieved through a combination of ecological processes and management activities. While the landscape is predominantly natural-appearing, there are some locations where the vegetation composition, structure, or pattern is slightly or moderately altered. The scenic integrity objectives would range from low to high.

2.2 National Forest Management Act (16 U.S.C. 1604)

This act provides the basis for supplying continued resources from these forests while accounting for the environmental and economic impacts. National Forests are required to write and reference individual forest plans, plan for proper reforestation, report accomplishments, provide economic aid to schools and roads, among many other things.

2.3 Multiple Use, Sustained Yield Act of 1960 (16 U.S.C. 528 – 531)

The Multiple Use, Sustained Yield Act of 1960 (Public Law 86-517) "authorizes and directs that the national forests be managed under principles of multiple use and to produce a sustained yield of products and services, and for other purposes."

2.4 The Clean Air Act (42 U.S.C. Chapter 85)

All land managers must manage smoke in accordance with the Clean Air Act and the regulations and policies of the Environmental Protection Agency (EPA).

2.5 Northeast Washington Forestry Coalition (NEWFC)

The Colville National Forest and the Northeast Washington Forestry Coalition entered into a Memorandum of Understanding (MOU) to provide a framework of cooperation and to facilitate community-based collaborative processes for forest health restoration activities on the Colville National Forest. The recommendations concerning regeneration harvests are considered when implementing stand-level silviculture prescriptions.

3.0 Topics and Issues Addressed in This Analysis

3.1 Purpose and Need

The full text of the purpose and need for this project can be found in the EA. The vegetation resource drives important components of the purpose and need such as the need to improve forest structure and contribute to the economy of the surrounding communities. In summary, vegetation proposals would address the following:

- Moving forest stands toward their historical range of variability for structure, patch size, and tree species composition (Forest Plan 2019 page 34);
- Reducing the potential for high-severity wildfires in the wildland-urban interface areas, providing protection for communities and diversity within stands; emphasizing fuel treatments in wildland urban interface and areas that exhibit the potential for high-severity fire behavior that could impact private or other agency lands; and establishing or maintaining a pattern of treatments that are effective in modifying fire behavior, as identified in individual community wildfire protection plans (Forest Plan 2019 page 39);
- Improving aquatic and riparian habitat conditions (e.g., support native aquatic and riparian dependent plant and animal species, distribution of conditions is similar to reference condition watersheds, hydrologic connectivity, and sediment regime is within the natural range of variation) (Forest Plan 2019 pages 50-51);
- Improving habitat conditions (e.g., amount, distribution, and connectivity of habitat, forage availability, seclusion) for big game, surrogate species, and federally protected species such as grizzly bears (Forest Plan 2019 pages 59-60);
- Supporting local jobs and labor income within the counties surrounding the forest through a predictable and sustained flow of timber and forest products within the capability of the ecosystem (Forest Plan 2019 pages 87 and 184).
- Providing a system of safe and sustainable authorized roads and bridges that provides public and administrative access where suitable and supports forest management objectives (Forest Plan 2019 page 71).

3.2 Issues

No key issues were identified for the project. Key issues are measurable or noticeable effects that are enough to drive the development of additional alternatives.

3.3 Resource Indicators and Measures

The metrics in Table 1 are used to describe and quantify the direct and indirect effects of silviculture and fuels treatments to resources from the alternatives included in this EA.

Table 1. Resource indicators and measures for assessing direct and indirect effects

Resource Element	Resource Indicator	Measure (Quantify if possible)	Used to address: P/N, or key issue?	Source (LMP S/G; law or policy, BMPs, etc.)?
Forest Structure	Changes in forest structure due to proposed treatments	Quantification of structural stage, changes to structural stage	Yes	*FW-STD-VEG-03. Timber Production* *FW-STD-VEG-04. Even-Aged Harvest Openings* *FW-STD-VEG-05. Restocking* *FW-STD-VEG-06 and FW-STD-VEG-07 . Even-aged Management* *FW-STD-VEG-09. Timber Harvest* *FW-GDL-VEG-03. Large Tree Management* Research articles, Forest Activities Tracking System (FACTS), Light Detection and Ranging (LiDAR) data
Forest Health and Wildfire Resiliency	Stand Density/Stocking Levels/Mortality	Basal area (BA), Trees per acre (TPA), Stand Density Index (SDI), diameter, and volume accretion and mortality.	Yes Purpose and Need	*FW-STD-VEG-05. Restocking* *FW-STD-VEG-06 and FW-STD-VEG-07 . Even-aged Management* *FW-STD-VEG-08. Harvest Systems* *FW-STD-VEG-09. Timber Harvest* *FW-GDL-VEG-03. Large Tree Management* Research, stand exams, Forest Vegetation System (FVS) modeling, aerial photogrammetry, Pend Oreille County CWPP
Wildland Urban Interface (WUI) and Historical Infrastructure	Defensible zones such as fuel breaks near structures and private property, strategic fuel treatments.	Acres treated within identified WUI	No	*FW-STD-VEG-01. Wildland Fire Protection of Natural Resources and Property* Flame Act, CWPP, NWCG Incident Response Pocket Guide (IRPG) Page 12

Resource Element	Resource Indicator	Measure (Quantify if possible)	Used to address: P/N, or key issue?	Source (LMP S/G; law or policy, BMPs, etc.)?
Air Quality	Air Quality Index (AQI)	Days of AQI in healthy range during prescribed burning season. (April, May, September, October, November)	Yes, Purpose and need	*FW-STD-AIR-01. Air Quality* Clean Air Act, Washington State Smoke Management
Firefighter and Public Safety	Potential Fire Engagement Zones and Access	Fuels Reduction acres and new system road miles.	No	*FW-STD-VEG-01. Wildland Fire Protection of Natural Resources and Property* Professional Opinion, Risk Management, IRPG NWCG Incident Response Pocket Guide Page 1

4.0 Proposed Action

The proposed action would meet the Purpose and Need (P&N) for the Ione project. The P&N was developed using direction from the LMP and other applicable laws and regulations. All treatments proposed under this alternative take into consideration the Standards and Guidelines from the LMP and all applicable laws and policies.

This alternative proposes both commercial and non-commercial harvest treatments to meet the purpose and need and to move the area towards the Desired Future Condition (Table 2) on lands suitable to timber production or areas where multi-use purposes are met. Approximately 7,875 (39%) of the 20,435 acres would be commercially harvested to improve stocking levels, stand vigor, and move stands towards the historical range of variability of structural stages. An additional 1,095 acres (outside of planned commercial treatment areas) may be treated for hazardous fuels with underburning.

Table 2. Proposed silvicultural treatments and desired future conditions

Silviculture Prescription	Definition	Regeneration Species (desired species for planting or natural seeding)	Proposed Action Acres
Commercial Thinning	An intermediate harvest method that removes suppressed, intermediate, and codominant trees. However, some dominants may be removed to meet stand density targets or create a desired species composition.	N/A	3505

Silviculture Prescription	Definition	Regeneration Species (desired species for planting or natural seeding)	Proposed Action Acres
Shelterwood with Reserves	A regeneration harvest method that removes trees except those needed for regeneration purposes. Prepares the seed bed and creates a new age class of trees. Reserve trees would be retained to create a two-aged stand of a desired species composition. Additional live trees would be retained for reasons other than regeneration, such as trees meeting the large tree guidelines, wildlife trees, or trees that would be retained for other silvicultural reasons.	White pine, western larch, ponderosa pine, Douglas-fir.	1240
Mixed Treatment	A combination of both Commercial Thinning and Shelterwood with Reserves.	White pine, western larch, ponderosa pine, Douglas-fir.	3135
Precommercial Thin	The cutting of small trees, generally less than 5” dbh, to reduce stocking density, change species composition, and increase growth or improve forest health. Residual trees are typically western larch, white pine, ponderosa pine, Douglas-fir, though other species may be left.	N/A	2045
Prescribed Underburn, Natural Fuels Units	Manipulation of a site by prescribed burning to enhance the success of natural regeneration, reduce fuel accumulations, and reintroduce fire to the landscape.	Ponderosa pine, western larch, aspen	1,095
Prescribed Underburn, Harvest units	Prescribed burning to enhance the success of natural regeneration or to reduce surface fuels for site preparation for artificial planting.	Ponderosa Pine, Western Larch Douglas Fire, Aspen	2,160
Whip Felling	Removal of small damaged trees during commercial harvest. Typically removes trees less than 7 inches diameter.	N/A	3380
Mechanical Piling/Mastication and Burn Piles	Piling of harvest slash to reduce surface fuels. Piles are subsequently burned if they cannot be utilized for commercial or other purposes. This treatment may be followed up at a later date with underburning.	N/A	5,720

The Proposed Action is estimated to produce between 40-60 million board feet of timber. Along with harvesting live, green trees, some dead and dying trees would be removed. Dead trees that pose a safety or operational hazard would be removed while meeting the required snag density for primary cavity excavators across the project area. Some of the economic value of the dead wood may also be utilized.

Roads are an important part of necessary infrastructure used to carry out the management activities described above. Road reconstruction and temporary road construction in the planning area provides access to proposed treatment areas. New road construction is planned for current and future land management (e.g., timber harvest, fire suppression, and post-harvest activities such as planting, prescribed burning, and RMA improvements).

Proposed activities within or adjacent to riparian habitat conservation areas (RMAs) would follow the standard practices provided in the Two Zone Riparian Management Strategy. Treatment objectives in RMAs include:

- Maintain, convert or trend stands towards longer lived, fuller crowned species that are suitable for the site, to provide shade and large trees consistently over time.
- Retain large, healthy conifers where appropriate
- Maintain and improve forest health for the foreseeable future. A healthy stand will provide shade, large wood recruitment, as well as stability over the long term in riparian ecosystems.
- Promote soils by reducing disturbance, compaction, erosion, routing of surface water to water sources, and desiccation of RMA soils
- Promote hardwood species where appropriate
- Priority area for management of invasive species
- Decrease potential of high intensity/high mortality wildfire by various treatments including, reduction of ladder fuels, reducing canopy bulk density, variable density thins, etc.
- Trend riparian management areas toward HRV potentially changing the structural stage, species composition, and natural processes (e.g., fire).
- Consider effects of climate change with treatments that favor a more diverse species content and stand structure.
- Maintain vertical and horizontal cover and landscape connectivity for wildlife (e.g., late-closed associated species, parturition for big game, sensitive invertebrates).

4.1 Project Design Features and Mitigation Measures

Slash piles composed of a majority lodgepole or ponderosa pine, which are at risk to create or continue the spread of bark beetles, should be burned, trampled with heavy machinery, chipped, lopped and scattered into small pieces, or otherwise removed from the site or mitigated by December 15 of each year, where feasible. Fresh pine slash created by winter operations should be treated prior to beetle emergence, June 1, where feasible to do so (Edmonds et al. 1997, Kegley et al. 1997).

5.0 Methodology

Silvicultural activities impact forest vegetation through several different measures of stand conditions. Measures of stand condition that influence forest tree health include:

- stand structure (tree size, arrangement)
- stand density (basal area, Stand Density Index (SDI), trees per acre (TPA),
- the overall tree composition of the stand as described by TPA.
- tree and stand growth changes over time
- forest health and mortality trends

Stand Structure

The structure stage by vegetation type is assessed across the landscape primarily through data derived from LiDAR. Stand exam data, aerial photos, and field reconnaissance were used to confirm LiDAR observations. Structure data was also be obtained through district records of past activities or stand exams. Stand exams were conducted in 2018 across various structure stages. Patches of potentially larger diameter trees were also identified using LiDAR. These will be checked during sale preparation activities (unit layout, marking).

Stand Density and Stocking

Stand density is described using various measures such as basal area (BA), Stand Density Index (SDI), and stand mortality. It is a critical measure in determining current and future forest and stand health.

Basal area is the computed measure of the cross-sectional area occupied by trees (including bark), as measured at breast height (Helms 1998). Basal area is strongly related to growing stock and wood production, is easily measured, and the results are consistent from measurement to measurement (Tappeiner et al. 2007).

SDI is a relative measure of density based on average diameter and number of trees per acre (Smith 1986). It is an analysis of competition-induced mortality to determine the various densities at which self-thinning of stands (tree mortality) are observed (Drew and Flewelling 1977).

Stocking typically compares a current density measure such as basal area against the same value of a “normally” stocked stand (Dunning and Reineke 1933, Cochran et al. 1994). Normal stocking can be defined as the highest density a forest stand can obtain before mortality rate exceeds the growth rate of the stand. “Normal,” in the context of forest stands, is considered the point at which site occupancy is maximized.

Calculating stand density helps determine a stand’s susceptibility to mortality. Research shows thinning reduces the severity of insect and disease damage to a stand (Cochran et al. 1994). Less competition increases the health and vigor of the remaining trees reducing the risk of insects and disease.

Tree and Stand Growth

The Forest Vegetation Simulator (FVS) was used to process stand exam data and model basal area, SDI, mortality, trees per acre, and diameter growth over time. As with any model, there are limitations to its use and data output and information should always be carefully considered. To estimate existing conditions and predict future stand conditions, data from stand exams were analyzed using: Forest Vegetation Simulator (FVS) Growth and Yield Model, Northern Idaho / Inland Empire Variant; and the Fire and Fuels Extension (FFE) to the Forest Vegetation Simulator. (Dixon 2018).

Forest Health Mortality Trends

Definitions of forest health vary, but the most widely known concepts include, but are not limited to:

1. a forest that is resilient to change and disturbance,
2. the ability of forests to bounce back after being stressed,
3. the ability of the forest ecosystem to recover from natural and human stressors, and
4. a diverse forest that maintains complexity and natural processes while providing for human needs (Edmonds et al. 2000).

Mortality is a natural process that occurs through stand competition and from natural disturbance processes. Levels of mortality from disturbance is an indicator of ecosystem resilience.

Fuels Treatment Effectiveness

FVS was also used to simulate prescribed fire in harvest units. Through these runs, we analyzed prescribed fire effects on 1000 fuel loadings, canopy base height, and crown bulk density. The use of FVS modeling aids us in determining proper treatments throughout the project. The values are meaningful in determining the potential effects of prescribed burning post-harvest and are indicators of future fire behavior and potential for fire control effectiveness.

5.1 Information Sources

Peer-reviewed scientific articles, literature, books, white papers, and in some cases, references to unpublished data were used to support proposed activities. Geographic Information Systems (GIS) software was used to produce maps and calculate data and statistics needed for this report. Professional knowledge is an important source of information and is derived through sampling, observation, and historical study. Another source of information comes from collaborative processes such as NEWFC and other stakeholder comments during scoping and project field trips.

5.2 Incomplete and/or Unavailable Information

Planned silvicultural methods (e.g., commercial thinning and regeneration harvests) may change as a result of further field work during the development of stand-level silvicultural prescriptions. The field work conducted during prescription development is more intense where a majority of each treatment unit is visited. During planning, a sample of units is visited to check information gathered from stand exams, LiDAR, and aerial photogrammetry.

5.3 Spatial and Temporal Context for Effects Analysis

The direct, indirect, and cumulative effects analysis is based on the spatial area and temporal (time) boundaries detailed below.

5.3.1 Affected Spatial Area

Forest conditions are analyzed at both the stand and landscape-level. HRV conditions of forest structure were analyzed at the watershed level, which differs from the planning area boundary. The planning area boundary does not follow the watershed boundaries, but forest conditions must consider all vegetation within the watersheds that intersect the planning area.

5.3.2 Affected Temporal (Time) Boundary

The analysis measures effectiveness of vegetation treatments both in the short and long term. Effects of treatments occurring within the 10 years would be considered as short term. Long term effects would be those occurring 11 to 50 years following treatments.

6.0 Existing Condition

6.1 Vegetation

The Ione analysis area is 20,435 acres and falls within the roughly 41,800-acre Sweet Creek-Pend Oreille River and 17,600-acre Big Muddy Creek subwatersheds in the northeast corner of Washington State. Vegetation treatments would be implemented on a portion of the 18,862 acres of NFS land within this analysis boundary. The rest of the area, approximately 1,573 acres (8 %), are privately-owned. Much of the NFS land within this project area is contiguous. However, there are multiple sections of private land throughout the project area.

6.1.1 *Past Management Activity and Disturbance*

Past harvest activities on National Forest System land from approximately 1955 to present are identified in Table 3. Historic harvest activities also occurred prior to 1955 and as far back as the late 1800s and early 1900s. There has been fuels treatments in post-harvest timber slash in the treatments as well. According to the FACTS reporting database, 811 acres of under-burning in slash and 1,032 acres of slash pile burning has been completed in the Ione Analysis area.

As was the case elsewhere in the intermountain west, human settlement (mostly of Euro-American descent) often altered the historic fire regime. There is limited mapping available regarding wildfire history in the Ione area prior to the 1980’s for fires under 100 acres. A fire history map is located in the project record.

Table 3. Past commercial harvest activity on lands administered by the CNF

Harvest Rx*	Acres Harvested	% of Total Harvest
Clearcut (HCC)	2736	26%
Seed Tree (HCR)	291	3%
Shelterwood (HSH)	4759	46%
Commercial Thinning (HTH)	617	6%
Other (salvage, improvement thins, selection harvest)	2014	19%
Total	10417	100%

6.1.2 *Vegetation Types*

Forested plant association groups (PAGs) were assigned to Landfire Biophysical Settings (BpS) and given a subsequent common name vegetation type. Landfire biophysical settings represent vegetation that may have been dominant on the land before European settlement and are based on an approximation of the historical disturbance regime (LANDFIRE 2014). There are essentially five vegetation types within the Ione analysis area (Table 4). Approximately 143 acres of NFS land within the analysis area are currently identified as “non-forested” which means those acres are unsuitable for timber production (i.e., does not grow trees well).

Table 4. Vegetation Types

Vegetation Type	Acres	Percent
Douglas-fir Dry	7936	39%
Northern Rocky Mountain Mixed Conifer	10207	50%
Western redcedar / Western hemlock	1829	9%
Subalpine fir / Lodgepole pine	220	1%
Spruce / Subalpine fir	100	0.5%
Non-forested	143	0.5%
Total	**20435**	**100%**

6.1.3 Resource Indicators

6.1.3.1 Forest Structure

Tree structure is classified into five general groups based on diameter and canopy cover as shown in Table 5 and **Error! Reference source not found.**. The diameter is based on the quadratic mean diameter in inches of trees whose heights are in the top 25% of all tree heights in the stand. This generally means the diameters of the larger co-dominant trees (trees in the upper canopy) in a stand are used to define the structure class (USDA Forest Service 2019).

Table 5. Structure class definitions based on canopy cover and diameter

Structure	Definition
Early	Trees less than 10” dbh or canopy cover < 10%
Mid Open	Trees 10-20” dbh, canopy cover ≥ 10% and < 40%
Mid Closed	Trees 10-20” dbh, canopy cover ≥ 40%
Late Open	Trees ≥ 20” dbh, canopy cover ≥ 10% and < 40%
Late Closed	Trees ≥ 20” dbh, canopy cover ≥ 40%

Error! Reference source not found. and Table 6 identify the current and historic condition of vegetation type by structure stage for the two watersheds within the project area.

Table 6. Historical Range of Variability Values by Vegetation Type on NFS Lands in Sweet Creek Watershed

Vegetation Type	Early	Mid Open	Mid Closed	Late Open	Late Closed
Douglas-fir Dry Current (%)	**6**	2	**77**	**0**	14
Douglas-fir Dry Historic (%)	6-16	2-8	4-13	38-78	1-32
Northern Rocky Mountain Mixed Conifer Current (%)	**4**	3	**80**	**0**	**13**
Northern Rocky Mountain Mixed Conifer Historic (%)	9-25	1-3	18-30	4-6	44-60
Western Redcedar / Western Hemlock Current (%)	**4**	**3**	**72**	0	21
Western Redcedar / Western Hemlock Historic (%)	4-24	0	7-27	0	55-83
Subalpine fir / Lodgepole pine Current (%)	**8**	**18**	**74**	0	**1**
Subalpine fir / Lodgepole pine Historic (%)	45-65	0	33-53	0	3
Spruce / Subalpine fir Current (%)	**1**	**3**	**93**	0	**3**
Spruce / Subalpine fir Historic (%)	14-46	0	13-41	0	29-57

Early

The watershed is deficient in the early structure stage for all vegetation types except for the Douglas-fir dry and Western Redcedar/Western Hemlock types.

Mid-open

The Douglas-fir dry types are deficient in the mid-open structure stage. The other vegetation types have a surplus of this stage.

Mid-closed

The Western Redcedar/Western Hemlock, Subalpine Fir/Lodgepole Pine and Spruce/Subalpine Fir vegetation types have a surplus of the mid closed structure stage.

Late-open

Douglas-fir dry and Northern Rocky Mountain Mixed Conifer are deficient in late closed stand structure. The other vegetation types did not historically have this stage and are within HRV.

Late-closed

The watershed is deficient in late-closed stand structure for all vegetation types except for the Douglas-fir dry vegetation type.

Table 6. Historical Range of Variability Values by Vegetation Type on NFS Lands in Big Muddy Creek Watershed

Vegetation Type	Early	Mid Open	Mid Closed	Late Open	Late Closed
Douglas-fir Dry Current (%)	**11**	3	**72**	**0**	14
Douglas-fir Dry Historic (%)	6-16	2-8	4-13	38-78	1-32
Northern Rocky Mountain Mixed Conifer Current (%)	**11**	1	**70**	**0**	**18**
Northern Rocky Mountain Mixed Conifer Historic (%)	9-25	1-3	18-30	4-6	44-60
Western Redcedar / Western Hemlock Current (%)	**8**	**1**	**54**	0	37
Western Redcedar / Western Hemlock Historic (%)	4-24	0	7-27	0	55-83
Subalpine fir / Lodgepole pine Current (%)	**8**	**7**	**74**	0	**11**
Subalpine fir / Lodgepole pine Historic (%)	45-65	0	33-53	0	3
Spruce / Subalpine fir Current (%)	**17**	**7**	**64**	0	**11**
Spruce / Subalpine fir Historic (%)	14-46	0	13-41	0	29-57

Early

The watershed is deficient in the early structure stage for the Subalpine Fir/Lodgepole Pine vegetation type.

Mid-open

The Western Redcedar/Western Hemlock, Subalpine Fir/Lodgepole Pine and Spruce/Subalpine Fir vegetation types are deficient in the mid-open structure stage.

Mid-closed

All vegetation types have a surplus of the mid closed structure stage.

Late-open

Douglas-fir dry and Northern Rocky Mountain Mixed Conifer are deficient in late closed stand structure. The other vegetation types did not historically have this stage and are within HRV.

Late-closed

The watershed is deficient in late-closed stand structure for all vegetation types.

Patch size and composition of forest structure

Currently, the forested landscape in this project area is fairly homogenous with uniform canopy cover (aerial photos, LiDAR structure). There are some natural openings where meadows occur or where the terrain is rocky or of low site productivity.

Historic forests had a higher composition of widely distributed large, old trees over a much broader area due to low, mixed, and high severity disturbances. Many of these trees were resistant to fire and survived extended droughts (e.g. ponderosa pine, western larch, and to an extent, Douglas-fir and white pine). Old trees of fire intolerant species were more common as fire frequency decreased and in wet microsites (Hessburg et al. 2015). Stine et al. 2014 also notes that historic dry and moist forests in Oregon and Washington may have had fewer than 70 trees per acre for small, medium, and large trees.

Research on the historical patch size and arrangement of forest structure in western forests is ongoing. Recent characterizations of mixed-severity fire regimes in the region confirm that complex landscapes were maintained with many small patches and few large patches (Perry et al. 2011). Patch size by vegetation type is described in Table 7. Historical photos of this area from 1935 show more open forests with large patches of early structure stages. By 1935, patch size and arrangement were likely affected by fires, grazing, homesteading, and some timber harvest.

Table 7. Patch size by vegetation type

Vegetation type	Patch size	Opening size	Description
Douglas-fir dry	Large	Primarily small (less than 5 acres) with occasional openings greater than 10 acres in very limited circumstances. Openings less than 40 acres in nearly all cases.	Larger patches of open-canopied stands would have included tree clumps and openings at a scale finer than that of an individual stand.
Northern Rocky Mountain Mixed Conifer	Large (generally 500-2000 acres)	Openings generally less than 40 acres in size, with the majority of patches being less than 5 acres in size.	Mixed severity fire generates variable patches and openings, though most openings in this type would have historically been relatively small.

Vegetation type	Patch size	Opening size	Description
Western red cedar / Western hemlock	Large (generally 50-2000 acres)	Generally commensurate with patch sizes.	The primary limiting factor on patch and opening size for this type is the spatial arrangement of the vegetation type itself. Because it does not generally occur in large contiguous areas of the Colville, smaller patches and openings would occur here than typical for this vegetation type.
Subalpine fir / Lodgepole pine	Small (generally 5-200 acres)	Highly variable, with many small-medium patches (less than 40 acres) and a few larger patches up to 1,000 acres or more in size.	Predominantly smaller patches would have been interspersed with few, larger patches. The larger patches were historically created during extreme fire weather events much as they are today.
Spruce / Subalpine fir	Small (generally 5-20 acres)	Generally commensurate with patch sizes.	Both patch and opening size is primarily limited by spatial arrangement on the Colville National Forest. As a result, smaller patches and openings would occur here than is typical for this vegetation type.

6.1.3.2 Stand Density (BA, TPA, SDI)

Stand density is described by basal area (BA), trees per acre (TPA), and stand density index (SDI). Density is a good measure of current and future growth and mortality in stands.

Table 8. Existing stand density condition in Ione analysis area.

Resource Element	Resource Indicator	Measure	Mean	Range
Stand Density	Basal Area (BA)	Square feet per acre (ft^2/ac)	187 ft^2	123-254 ft^2
Stand Density	Trees per acre (TPA)	Number of trees per acre	197	141 – 290
Stand Density	Stand Density Index (SDI)	Relative density units	306	224 - 423

6.1.3.3 Mortality, Disturbance Agents

Table 9 describes the existing condition of mortality based on volume gain (may also be described as "accretion") and loss (may also be described as "mortality"). Volume gain and loss is measured by the change in cubic foot growth per year (Table 9).

Table 9. Existing condition describing mortality in the analysis area.

Resource Element	Resource Indicator	Measure	Existing Condition Average	Existing Condition Range
Forest Health	Mortality	Volume gain and loss (cubic feet per acre per year)	Gain: 131 Loss: 40	Gain: 94-176 Loss: 16-86

Disturbance[1] is both a natural and necessary part of forest ecosystems; it is what drives the stages of forest succession and allows trees to grow and recycle or die (Campbell and Leigel 1996). There are several disturbance agents that can change the structure and composition of forests such as fire, weather, insects, pathogens, and humans. Bark beetles and tree defoliating insects were generally endemic to the landscape because of historic disturbance regimes such as fire (Hessburg et al. 2014). Fire, insect, and disease regimes are currently driven by a warming climate, past management, and contagious patterns of fuels and host trees, fostering increased numbers of larger and more severe disturbances than occurred historically (Hessburg et al. 2015). Mountain pine beetle, fir beetle, root rot *(Armillaria* and *Annosus*), *Echinodonctium tinctorum* (Indian paint fungus), and *Phellinus pini* have all been detected in the project area in small, isolated areas. None of these disturbance agents have been observed at levels where entire stands are being killed off by one or more agents. There are pockets of dead and dying trees from insects and disease, but not entire stands at this point in time.

Based on the data in Table 910, the amount of volume loss is approximately 31% of the volume gain in cubic foot volume per acre per year. Mortality as a percentage of gross growth is a useful health indicator because stands can be considered healthy when growth and mortality are appropriately balanced (O'Laughlin and Cook 2003). There are no set judgments on appropriate balance, which varies by stand type and age (O'Laughlin and Cook 2003).

6.2 Fire

6.2.1 Disturbance and Fire History

As was the case elsewhere in the intermountain west, human settlement (mostly of Euro-American descent) often altered the historic fire regime. Natural and human disturbances have shaped both structure and composition within the analysis area (Arno et al 1980).

Major human-caused, disturbances within the analysis area include homesteading (land clearing), timber harvest, mining, and noxious weed introduction. Logging and land clearing has been occurring in the project area since the early 1900s. Early reports document that ranchers and homesteaders cleared tracts of land to raise cattle and crops. Much of the homesteading land was transferred to the Forest Service in the 1930s. Beginning in the 1950s, the Forest Service record keeping improved considerably and data was recorded as timber was harvested. Harvest methods and removal of timber products from the national forest have changed substantially over time. Early harvest methods (1950s, '60s, and '70s) focused primarily on financial objectives of providing low-cost wood products. Harvesting often occurred in the locations with the highest volume and most easily accessible stands. Timber harvest often occurred within riparian areas and adjacent to streams (Chance 1991).

Natural disturbances include fire, insects and diseases, wind, snow, and ice storm events. At the landscape scale natural disturbances occurred at both regular and irregular intervals with varying degrees of intensity. Historically, fire has been the primary disturbance factor driving both species composition and structure. (Smith et al 1997) High severity, low frequency fire regimes favor the shade-tolerant and fire-intolerant tree species such as western red cedar and western hemlock. These species are generally found growing within the more protected draws and cooler, north-facing aspects. Low severity, high frequency fire regimes favor the shade intolerant and fire-tolerant species such as western larch and ponderosa pine. These species are generally found on the more open ridges and dryer, south-facing aspects (Agee 1993). There is limited mapping available regarding wildfire history in the Ione area prior to the 1980's. Qualitative comparisons with aerial photographs from the 1930s to 2009 indicate a general trend of the

[1] In ecology, a disturbance is a temporary change in average environmental conditions that causes a pronounced change in an ecosystem.

establishment of forest cover, in areas that were not previously forested prior to the arrival of European settlements. This phenomenon is largely due to the removal of fire as a recurring disturbance mechanism on the landscape (i.e., fire exclusion). Fire exclusion has allowed fuels to accumulate on the forest floor – the duff is thicker and the amount of down wood is probably greater (Smith and Fisher, 1997; DeLuca and Sala, 2006).

The second major observed effect of fire exclusion is the shift in species composition away from dominance in fire-resistant species (ponderosa pine and western larch) to a substantial increase and co-dominance of fire-intolerant species, primarily western redcedar and grand fir. The warm-dry stands now have a relatively dense mid and understory component of grand fir, Douglas-fir and western red cedar.

6.2.2 Fire Regime

Fire regime is the characteristic fire trait occurring in an ecosystem. In other words, it is the general role wildland fire would play across a landscape in the absence of modern human intervention (Agee 1993). Fire regimes have been defined in terms of fire frequency, severity, stand effects, landscape spatial patterns, and season of occurrence. However, fire frequency and severity are the most common traits studied by ecologists and used by land managers (Haan and Bunnell 2001).

Fire behavior and vegetation response is classified into three broad categories based on the severity of the fires characteristic to that regime. These categories are low, mixed (or moderate), and high severity fire regimes. Site productivity and fire frequency, or the amount of time between fire events, also plays an important role in the fire regime. In essence, the higher site productivities and longer fire frequencies generally allow for more closed canopy conditions. In contrast, marginal growth sites with short fire frequencies contribute to open forest canopy conditions. Below are the main fire regimes represented within the project area boundary based on land fire analysis.

Fire Regime I- The ***high frequency, low severity*** fire regimes are those with a relatively short fire return interval (<35 years) and low fireline intensity. These fires have little effect on soil heating or overstory vegetation. Typically, 90% or more of the overstory vegetation survives this kind of fire (Morgan et al. 1996). In this regime, surface fuels typically carry fire and only litter, herbaceous material, foliage and woody undergrowth (i.e., “fine fuels”) are consumed. Examples in the analysis area include south and west-facing slopes with an overstory of fire-tolerant ponderosa pine and Douglas-fir, and an understory dominated by low brush, bunchgrasses and/or rhizomatous grasses Fire exclusion has resulted in increased fuel loads in these stands. With a potential historic fire-return interval of 5 to 35 years, up to 10 fire cycles may have been eliminated from this ecosystem. Site visits indicate approximately 75% of these stands are currently in a departure from the HRV. The ***high frequency, low severity*** fire regime (Fire Regime 1) occupies ~20% of the analysis area.

Fire Regime III- The ***mixed* or *moderate severity***, fire regimes are the most complex fire regimes to categorize, as the fire frequency and fire effects are variable across the landscape. Mixed severity fires are those with an intermediate fire return interval (35 to 75 years) and have a variable fire severity. Typically, this fire regime produces irregular stand patches and clumps resulting from different fire severities (Agee 1993). At local and landscape scales, mixed severity fire regimes produce spatially uneven mosaics of even-aged stands, where stand replacement severity occurs frequently in small patches (1 – 5 acres) or infrequently in larger patches (5 – 15 acres). Warm-dry Douglas-fir/ninebark communities have a more frequent, lower severity fire regime with some stand-replacement activity, while cool-moist Douglas-fir/grand fir communities have a less frequent, higher severity fire regime that may have larger patches of stand replacement severity (5 – 15 acres). Moderate-severity fires generally kill lodgepole pine, Engelmann spruce, grand fir, western hemlock, young Douglas-fir and western red cedar. Western larch, ponderosa pine, larger-diameter Douglas-fir, western white pine, and occasional western red cedar may tolerate low intensity fires. These micro-sites that tolerate fire can serve as refugia for shade-tolerant/ fire-intolerant species and may allow for their establishment and encroachment of these fire intolerant species to move into drier, upland environments when fire cycles are missed. (Brown 2000) In these areas we are experiencing a moderate to sometimes dramatic departure (Condition Class II & III) from the HRV. Fire exclusion has resulted in an increase in ladder fuel abundance and continuity creating current conditions that are at increased vulnerability to uncharacteristic disturbance (primarily fire). The ***mixed*** **or** ***moderate severity*** fire regime (Fire Regime 3) makes up ~75% of the majority of the analysis area.

Fire Regime IV- The ***mixed*** **to** ***high severity*** fire regime is typically positioned on the landscape where the opportunity for ignition is limited. In the analysis area, shade-tolerant plant communities in moist or wet zones characterize these fire regimes. Western hemlock, western red cedar, and grand fir are common late-successional species in this fire regime and project area. High severity fire regimes often have understories of large down woody material, and mesic shrub and herbaceous species. The combined features of the understory generally favor a moist environment for most of the year. Wildfire usually only enters these areas during drought years (100+ years), and can burn with high intensity.). For early spring prescribed burning, these stands can serve as natural firebreaks as fuel moistures tend to stay high even late in the summer season. The ***mixed*** **to** ***high severity*** fire regime (Fire Regime 4) occupies ~5% of the analysis area. A current map of fire regimes in the project area is located in the project record.

Fire Regime Condition Class (FRCC)

A fire regime condition class (FRCC) is a classification of the amount of departure from the natural regime (Hann and Bunnell 2001). They include three condition classes for each fire regime. The classification is based on a relative measure describing the degree of departure from the historical natural fire regime. This departure results in changes to one or more of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances (e.g. insect and disease mortality, grazing, and drought) (FRCC Guidebook 2010).

FRCC is used to describe the degree of departure from the historic fire regimes that results from alterations of key ecosystem components such as composition, structure stage, stand age, and canopy closure (Agee 1993, Brown 1995). One or more of the following activities may have caused this departure: fire exclusion, high-grade timber harvesting, grazing, introduction and establishment of non-native plant species, insects or disease (introduced or native), or other past management activities (FRCC Guidebook 2010). Table 10 describes the attributes of each FRCC. The FRCC was determined using stand exam data, Colville National Forest Plant Association Groups (PAG) imagery and local historical fire records and is most useful at the landscape level. It is important to note the FRCC is highly variable across the analysis area; as with vegetation structure and composition, minor changes in slope, aspect, or topographic position can have dramatic effects on the vegetation pattern of the landscape. PAG imagery, a tool designed for landscape scale assessment does not always identify this variability at the project scale.

A fire regime condition class map with information on FRCC values in the project area is located in the project record.

Table 10. Fire Regime Condition Class Attributes (NIFC 2003)

Condition Class	Attributes
Condition Class 1	Fire regimes are within or near their historical range. The risk of losing key ecosystem components is low. Fire frequencies have departed from historical frequencies (either increased or decreased) by no more than one return interval. Vegetation attributes (species composition and structure) are intact and functioning within their historical range. A small amount of FRCC 1 exists in the analysis area. (~1%)
Condition Class 2	Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystem components has increased to moderate. Fire frequencies have departed from historical frequencies by more than one return interval resulting in moderate changes to one or more of the following: fire size, frequency, intensity, severity, or landscape pattern. Vegetation attributes have been moderately altered from their historical ranges. The majority of the analysis area is considered to be in Class 2. (~89%)
Condition Class 3	Fire regimes have been substantially altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed by multiple return intervals resulting in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape pattern. A small amount of FRCC class 3 exists in the analysis area. (~10%)

6.2.3 Wildland Urban Interface (WUI)

The community of Ione is located east of the project area and is considered a medium density area within the Pend Oreille Community Wildfire Protection Plan (CWPP). The Northeast Washington Forestry Coalition (NEWFC) has identified this area as a “Restoration Zone”. This zone has been identified by NEWFIC as being a priority treatment area for the Colville National Forest. The Pend Oreille County Community Wildfire Protection Plan has designated about 8,000 acres within the project area as “Wildland Urban Interface (WUI) Rural Lands.” These are described as sparsely populated areas outside of the urban development zone. The majority of these WUI designated areas have not received any known treatment to address wildfire concerns. Refer to WUI map in project folder or the Pend Oreille County CWPP.

There are multiple private inholdings within the project area. These are generally small inholdings with few or no permanent outbuildings. One permanent residence is known to be within the analysis area and 3 structures are known to exist within project area. The project area is immediately adjacent to private land and permanent residential structures. There are multiple transmission and power lines throughout the project area.

Structure Risk and Effect on State, County, and Private Ownerships within the Ione Wildland Urban Interface (WUI)

Home and structure risk from potential wildfire is largely dependent on the following: flammability of building materials; adjacent wildland fuels; and firebrands.

Flammability of building materials: The ignitability of building materials is the single most important consideration for determining structural risk during a wildfire event (Cohen 1999). Shake/shingle roofs, wood siding, decks and unscreened vents are especially vulnerable from both on and off-site ignition sources. The WA DNR and local county fire districts administer programs specifically designed to address this issue.

Firebrands: Firebrands are burning pieces of wood that can be lofted into the air and ignite structures or adjacent vegetation. Firebrands are an important ignition factor within the WUI. Flammable structures and vegetation can ignite and burn from firebrands lofted a half mile or more downwind from a wildland fire (Cohen 1999). No action taken would not change the risk firebrands pose to igniting structures, because fuel treatments would not be implemented that would affect vegetation characteristics near structures.

Adjacent wildland fuels: Wildland fuels on adjacent private ownerships include relatively open stands of immature ponderosa pine and Douglas-fir (FM 2, 5 and 9), closed stands of mature lodgepole pine, grand-fir, western larch, Douglas-fir and western red cedar (FM 8 and 10), and open stands of immature Douglas-fir and lodgepole pine with light to moderate logging slash (FM 11 and 12 respectively). Convective and radiant heat energy from a high intensity surface or crown fire can directly ignite wildland fuels at distances up to 120 feet (Cohen and Butler 1999). No action taken would not affect wildland fuels and treatments, fuel conditions would continue worsen over time as vegetation continues to grow and encroach on the Wildland Urban Interface.

6.3 Air Quality

The Ione Analysis Area is within a designated Class II airshed. Smoke originating within or potentially impacting this airshed is regulated by the Washington Department of Natural Resources – Smoke Management Division (WA DNR). The existing sources of particulate emissions within or near the Ione Analysis area include smoke from neighboring prescribed fire projects including, but not limited to, industrial mill sites, forest residue burning on National Forest System (NFS) and non-NFS lands; smoke from residential wood stoves and agricultural activities in the Pend Oreille valley (e.g., Cusick, Usk, Blueslide, Tiger, Ione, Metaline Falls); and vehicular dust and exhaust.

The closest current air monitoring site is located approximately 25 miles West in Colville, Washington and represents the closest realtime data set for the Ione Area. Unfortunately, there was no historical data sets that were usable for this analysis available. All realtime data is derived from the Washington Air Monitoring website https://fortress.wa.gov/ecy/enviwa/.

The next most representative air monitoring site is in Sandpoint, Idaho, approximately 50 miles Southeast of the town of Ione (Table 11). Air quality at this site is measured as AQI (Air Quality Index). The air quality index is a tool used to convey information to the public regarding local levels of air pollution and the associated health concerns. There are 6 levels of Air Quality Index (AQI)- Green 0-50 (Good), Yellow 51-100 (Moderate), Red 151-200 (Unhealthy), Purple 201-300 (Very Unhealthy), and Maroon 301-500 (Hazardous). Although local wildfires and some prescribed burning did contribute to some reduced air quality days, the majority of the poor air quality days are a result of wildfire smoke from surrounding areas (https://www.deq.idaho.gov/air-quality/regional-air-quality-reports/).

Table 11. Sandpoint Air Quality

Level of AQI	2019	2020
Green	204 (89.6%)	307 (90.5%)
Yellow	23 (10%)	28 (8.3%)
Orange	1 (0.4%)	1 (0.3%)
Red	0	3 (0.9%)
Purple	0	0
Maroon	0	0

7.0 Environmental Consequences

7.1 Proposed Action

7.1.1 Vegetation

This section describes the effects that each proposed activity would have on the existing vegetation condition, spatially and temporally.

Forest Structure

Table 12. Forest Structure Resource Indicators and Measures for the Proposed Action for Sweet Creek Watershed

Vegetation Type	Early	Mid Open	Mid Closed	Late Open	Late Closed
Douglas-fir dry					
Current (%)	**6**	2	**77**	**0**	14
Post-Harvest (%)	6	26	53	2	13
Historic (%)	6-16	2-8	4-13	38-78	1-32
Northern Rocky Mountain Mixed Conifer					
Current (%)	**4**	3	**80**	**0**	**13**
Post-Harvest (%)	4	25	57	1	13
Historic (%)	9-25	1-3	18-30	4-6	44-60
Western Redcedar / Western Hemlock					
Current (%)	**4**	**3**	**72**	0	21
Post-Harvest (%)	4	18	57	0	21
Historic (%)	4-24	0	7-27	0	55-83
Subalpine fir / Lodgepole pine					
Current (%)	**8**	**18**	**74**	0	**1**
Post-Harvest (%)	8	23	68	0	1
Historic (%)	45-65	0	33-53	0	3
Spruce / Subalpine fir					
Current (%)	**1**	**3**	**93**	0	**3**
Post-Harvest (%)	1	60	35	0	3
Historic (%)	14-46	0	13-41	0	29-57

Table 13. Forest Structure Resource Indicators and Measures for the Proposed Action and No Action for Big Muddy Creek Watershed

Vegetation Type	Early	Mid Open	Mid Closed	Late Open	Late Closed
Douglas-fir dry					
Current (%)	**11**	3	**72**	**0**	14
Post-Harvest (%)	11	3	72	0	14
Historic (%)	6-16	2-8	4-13	38-78	1-32
Northern Rocky Mountain Mixed Conifer					
Current (%)	**11**	1	**70**	**0**	**18**
Post-Harvest (%)	11	26	45	2	16
Historic (%)	9-25	1-3	18-30	4-6	44-60
Western Redcedar / Western Hemlock					
Current (%)	**8**	**1**	**54**	0	37
Post-Harvest (%)	8	13	42	0	37
Historic (%)	4-24	0	7-27	0	55-83
Subalpine fir / Lodgepole pine					
Current (%)	**8**	**7**	**74**	0	**11**
Post-Harvest (%)	8	23	68	0	1
Historic (%)	45-65	0	33-53	0	3
Spruce / Subalpine fir					
Current (%)	**17**	**7**	**64**	0	**11**
Post-Harvest (%)	1	60	35	0	3
Historic (%)	14-46	0	13-41	0	29-57

7.1.1.1 Direct Effects

Commercial thinnings and regeneration treatments would mainly take place in mid-closed stand structures, with patches of other structure stages occurring within the units. Treatments would affect forest structure by moving some mid-closed stands toward mid-open structure stages in the short-term, with others remaining mid closed.

Over the long term commercial treatments should increase growth and vigor helping the stands to move quicker towards later structural stages which we are lacking. Under the proposed action, canopy cover will be reduced in the short term and some stands will go from a closed structural stage to an open one.

Over time as trees grow larger due to increased growing space, light, moisture, and nutrients these stands would move from mid-open to mid-closed or late-closed.

The largest trees (20 inches dbh and greater) would mostly be identified for retention in all treatment types. This would trend stands toward late stand structures, which are currently deficient in most vegetation types. However, trees over this diameter may be removed for safety, operations, to meet desired conditions for structural stages, limit the spread of insect infestation or disease, where needed for fuel reduction, or to promote special plant habitats.

Species composition within a stand would be modified by removing trees through thinning. Shade tolerant trees that have a low tolerance for fire would be removed in higher quantities in Douglas-fir dry and Rocky Mountain Mixed Conifer vegetation types. Shade intolerant species which are more fire tolerant can be favored. There would also be exceptions to this such as developing thermal cover for big game, providing shade adjacent to riparian areas within dry to moist site vegetation types, or leaving trees with desirable for wildlife. Shade tolerant species would be left in appropriate historical vegetation types, in moist or wet aspects, or wet microsites.

Some late open and late closed stands would be harvested under the proposed action. Patches of late-open and late-closed stand structures, stands with biological legacies and groups of trees with diameters greater than 20 inches have been identified (**Error! Reference source not found.**) during field visits.

Precommercial thinning would change the structure stage of stands from mid closed to mid open immediately following treatment. These stands would trend towards mid closed over the next 30 years or more.

7.1.1.2 Indirect Effects

While one of the objectives of this project is to aid in moving the forest back to its HRV, an indirect effect would be the economic value gained from commercial treatments. The economic return from commercial harvest treatments could be used to do future precommercial thinning, prescribed burning, mastication, or other maintenance treatments. The proposed action for this project would provide economic benefit to the local economy through the harvest of approximately 59 MMBF of timber.

Some late-closed stands may be prone to high severity damage from wildfire, which would cause a change to the structure stage in the immediate patch. However, these areas are somewhat small and scattered throughout the project area, so they may be surrounded by treatment areas that decrease the rate of fire spread or severity. Some trees may be susceptible to wind damage if the surrounding stand is heavily cut.

If no action was taken then there would be no direct change of structural stages or trending of stages toward HRV conditions through commercial harvest, precommercial harvest, prescribed burning, and other actions in the short-term. There will be little to no increase in the amount of mid and late-open stands without some disturbance.

7.1.2 Forest Health and Wildfire Resiliency

Measures to evaluate for the proposed action for resource indicators of stand density, stocking levels, and mortality are shown in Table 14.

Table 14. Forest Health and Wildfire Resiliency Resource Indicators and Measures for the Proposed Action

Measure	Existing Condition	Proposed Action
Commercial Thinnings		

Measure	Existing Condition	Proposed Action
Basal Area (BA)	Avg: 187 ft² Range: 123-254 ft²	Target Avg.: 60-80 ft²
Trees per acre (TPA)	Avg: 197 Range: 140 – 290	Target: 40-100
Stand Density Index (SDI)	Avg: 306 Range: 224 - 423	100-160
Volume loss, cubic feet per acre per year	46 ft^3 /acre	10 ft^3 /acre
Regeneration Treatments		
Basal Area (BA)	Avg: 187 ft² Range: 123-254 ft²	Target Avg.: 20-50 ft²
Trees per acre (TPA)	Avg: 197 Range: 140 – 290	Target: 10-50
Stand Density Index (SDI)	Avg: 306 Range: 224 - 423	40-80
Volume loss (Mortality), cubic feet per acre per year	46 ft^3 /acre	6 ft^3 /acre

7.1.2.1 Direct Effects

In general, commercial treatments would promote retained trees to grow more vigorously, create conditions beneficial for prescribed burning, and increase resilience and resistance to disturbance. Mortality or volume loss would also be reduced.

As more acres of the slow growing or stagnant stands are brought under stocking level control, stand vigor would improve. Insects and diseases can be species specific in the range of hosts they would attack. By maintaining a species mix that contains multiple species within the stand, the risk of stand loss to any one single insect or disease is reduced and beneficial to long-term growth of the stand (Campbell and Liegel 1996; Carlson and Wulf 1989, Cochran et al. 1994, Edmonds et al. 2000). Therefore, by controlling basal area and reducing stocking, tree vigor would increase and changes in species composition would increase stand resiliency to insect and disease.

Basal area, trees per acre, and stand density index are directly decreased through removing trees during commercial harvest, pre-commercial thinning, and prescribed burning. Noncommercial treatments such as grapple piling, pile burning, and whip felling would also remove some small trees, driving density lower. Stand density may also decrease with planned underburns due to fire-related injury and delayed mortality. Tree planting would increase stand density over time as trees grow and allow for control of species composition. These trees would eventually grow into the available growing space over time due to the increase in sunlight, available nutrients and water, and planting. The extra growing space is beneficial to small trees to provide a longer period for increased growth and resilience.

Treatments along the urban interface would aid in reducing the risk of insect, disease and fires spreading between Forest service, private and other ownerships lands and vice versa.

Thinning and other stand treatments can influence subsequent fire behavior at the stand level by either increasing or decreasing fire intensity and associated severity of effects. There are differing views on how fires affect forests when fires occur post-treatment. Thinning can effectively alter fire behavior by reducing crown bulk density, increasing crown base height, and changing species composition to lighter crowned and fire-adapted species. Such intermediate treatments can reduce the severity and intensity of wildfires for a given set of physical and weather variables (Graham et al. 1997, Graham et al. 1999, Graham et al. 2004). A study conducted by Bradley et al. 2016 found that protecting forests from timber harvest resulted in lower fire severity. Another study found that Forest Service management was found to produce forest conditions most resilient to high-severity wildfire than some surrounding state or private ownerships (Charnley et al. 2017).

7.1.2.2 Indirect Effects

The economic return from commercial harvest treatments would be the same as in forest structure above,

Treatments within and around aspen stands would release aspen trees and clones that are currently suppressed by conifers. The increase in light and growing space from the removal of conifers would result in increased growth rates for aspen. Cutting individual aspen trees or using prescribed fire in these stands would increase aspen sprouting.

Indirectly, mortality could occur to the residual stand from logging damage or post-fire delayed mortality from underburn operations (Hood and Bentz 2007). Endemic insect activity may also contribute some amount of mortality to the stands in Ione, but these are likely to be minimized with the proposed activities in the area.

Removal of advanced regeneration may set the stand back from trending towards closed conditions for a longer time period. The benefit is added growing space for residual trees to continue growing at a faster rate.

Dense stands have a greater risk to stand replacing fires due to their closed canopy structure which enables the spread of fire from crown to crown. Multi-storied stand structures are often more susceptible to crown fires due to ladder fuels. Increased mortality from inter-tree competition, insects, and disease would result in more fuel and higher intensity fires.

There would be no silvicultural treatments to reduce stocking levels, improve stand vigor and growth, reduce crown fire and uncharacteristic fire risk, improve riparian habitat conservation areas (RMAs), or to plant early seral species such as, white pine, western larch and ponderosa pine. No action taken would not directly change structural stages or trend stages toward HRV conditions through commercial harvest, precommercial harvest, prescribed burning, and other actions in the short-term. Some trending may take place over the long-term due to tree mortality from stand density, disturbances such as fire, insects, and disease. However, this may also create unfavorable fuel loading conditions over time, potentially resulting in hazardous conditions for the WUI and firefighting efforts. Conversion of stands to shade tolerant species would continue (assuming little to no disturbance), also increasing the future hazard to insects, diseases and stand replacement fires. The probability of stand replacement by fire would continue or increase. Hardwoods would continue to be outcompeted by conifers and their abundance would decrease across the landscape.

Since no harvesting would take place, the economic value of the green, dead and dying trees would not be captured. Though the national forest does not necessarily plan treatments based on economic value, there would be no additional funding for other management activities. Typically, funding generated from timber sales helps the local economy, aids in monitoring, stand improvement, wildlife, fisheries, recreation, and fuel reduction projects. No prescribed burning would be implemented to reduce hazardous fuels or create stand conditions resilient to fire occurrence.

7.1.3 *Wildland Urban Interface (WUI) and Historical Infrastructure*

Table 15. Wildland Urban Interface (WUI) and Historical Infrastructure Resource Indicators and Measures for the Proposed Action and No Action

Resource Element	Resource Indicator	Measure	Existing Condition	Proposed Action
Wildland Urban Interface (WUI) and Historical Infrastructure	Defensible zones such as fuel breaks near structures and private property, strategic fuel treatments.	Acres treated within identified WUI	0 known acres of defensible space/ targeted WUI treatment identified	8000 acres of harvest and fuels treatment within CWPP designated WUI

Vegetation treatments throughout the identified WUI zones would contribute to long term (10+ years) reduction in uncharacteristic wildfire severity. As WUI continues to expand further into previously undeveloped areas, the previous, current, and future vegetation treatments result in the continued maintenance of these areas would become crucial to firefighting success over the next 20-30 years.

All proposed vegetation treatments within the identified WUI areas contribute positively to the resiliency and lessening of wildfire severity and the impact of wildfire on adjacent private property.

7.1.4 *Air Quality*

Although smoke from Hazardous Fuel and Commercial Harvest Activity Fuel burning may temporarily degrade air quality within the Ione analysis area and surrounding Pend Oreille River valley (where smoke tends to gather and accumulate), no reduction in measured Air Quality would result from these activities. Coordinated meteorological scheduling would be used to regulate all prescribed burns within the regional area, thus minimizing the potential for cumulative smoke impacts to the public. Prescribed burns would be scheduled and approved by the WA DNR only during periods of favorable atmospheric transport and dispersion. To ensure compliance with state and federal air quality standards, approved burning would be determined through monitoring and computer modeling of all scheduled and proposed emissions. This includes proposed burns from state, private and federal ownerships.

Vegetation management activities in this project will result in improved forest resilience to uncharacteristic wildfire within this project area. This would lead to a reduction in emissions if a large wildfire were to occur in the project area.

7.1.5 *Firefighter and Public Safety*

Table 16. Firefighter and Public Safety Resource Indicators and Measures for the Proposed Action

Resource Element	Resource Indicator	Measure	Proposed Action
Firefighter and Public Safety	Potential Fire Engagement Zones and Access	Fuels Reduction acres	8430 acres of improved engagement zones through vegetation treatment.

Increased firefighting access through the improvement and maintenance of forest system roads and more open stand conditions created by commercial harvest and prescribed burning will lead to improved long-term access (10 or more years). Previous and planned road maintenance in the project would allow for improved access by firefighting resources. Openings created through past USFS, DNR, private timber harvest, and underburning also may act as access routes for equipment including heavy machinery and aerial firefighting resources leading to more efficient suppression of wildfires. The additional acres in the Proposed Action would further increase access for firefighting resources.

8.0 Monitoring

All vegetation management projects would be monitored both during and after treatment to determine if management direction and guidelines are being met. Monitoring would check that marking is meeting the prescription and marking guide. Monitoring would also be conducted during harvest operations to insure prescriptions are being met. Post-harvest reviews would be conducted within one to three years after harvest to determine if the harvest met the prescription and if any changes to the fuels, site preparation, or reforestation are needed.

Annual Aerial Forest Insect and Disease surveys would identify the locations and severity of insect and disease populations. Particular attention would be made to monitor tree mortality and subsequent insect activity in units where prescribed fire is applied. The surveys would be reviewed by the silviculturist and would provide information on insect and disease trends, success of treatments, and provide information to inform future decisions.

Natural and artificial regeneration occurring following treatment would be evaluated for species composition and numbers of trees per acre. Survival surveys in plantations would be conducted the first and third years following harvest to ensure the unit is fully stocked with seedlings.

The silviculturist and fuels specialist would review a subset of the prescribed fire and fuels treatments to estimate levels of tree mortality and to determine if the surface and ladder fuels are being reduced to as proposed.

Fuels monitoring would occur in selected units and include pre-burn and post-burn photo/visual monitoring. In addition, photo-plots, duff/fuel depth measurements, and vegetation sampling plot monitoring may also be conducted.

During prescribed burning, smoke conditions would be monitored using a variety of methods (e.g., smoke camera, air quality sensors) and following the Interagency Prescribed Fire Planning and Implementation Procedures Guide (NWCG, PMS 484 2017).

A post-harvest silvicultural review would be done on a random sample of activity units within the analysis area no later than one year post-project completion. Information from field visits will help inform internal after-action reviews, identify the degree to which silvicultural objectives were met, and identify if any changes would be needed to post-harvest activities.

9.0 Cumulative Effects

9.1 Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

Cumulative effects on vegetation are analyzed at the watershed scale. A scale as large as the entire Colville National Forest of 1.1 million acres would tend to obscure effects of treatments occurring on a localized area of the Forest. Vegetative cumulative effects are additive, meaning they are the total of changes of proposed treatments to vegetative structure. The project scale analysis allows for comparison of changes that are occurring as a result of the past, present, and reasonably foreseeable projects within the two watersheds.

According to District records, approximately 9103 acres of treatments have occurred on National Forest System lands within the Ione project area in the past 50 years. These treatments included: commercial thinning, group selection, improvement cut, seed tree cut, shelterwood, and clear cut. The most recent commercial harvest activities occurred in the late 90’s and early 2000s. approximately 66% of the 6083 acres harvested was a regeneration harvest, namely a clearcut or shelterwood harvest (Table 3). These treatments shifted forest structure to early and mid-open structures at the time. Most of these past treatments are now mid closed. There are no other known timber sales that are active or planned within this area at this time across all other ownerships.

Continued cattle grazing, dispersed recreation, and firewood are anticipated to be ongoing and reasonably foreseeable future activities. None of these activities add to the cumulative effects on vegetation since the effects are small and localized effects to forest structure, stand density, and mortality trends.

9.1.1 Forest Structure

Forest structure would be impacted by the commercial treatments for the next 30 to 100 years or more.

Overall, stand structures have been changed from a mixture of all structure stages to mostly mid closed until now as a result of past activities (Table 6 and Table 7). Implementing the proposed action would move additional stands into the mid open structure stage. Treatments on other ownerships amount to about 2 percent of the total area of the Sweet Creek and Big Muddy Creek watersheds. Treatments on state and private land changed forest structure to early and mid-open stand structures.

Over the long-term, commercially thinned stands would increase average diameters greater than 20 inches and would cumulatively add to the late structure across the landscape. However, harvests on other land ownerships may or may not allow trees to grow into these structure stages in the foreseeable future, depending on their forest management objectives.

Prescribed burning on over 8,970 acres within commercial harvest units and fuels units 1-7 would also add a cumulative effect to forest structure. There is a limited history of wildfire in the project area and watersheds, so there is no added effect to forest structure from wildfire. Smaller diameter trees are targeted for removal in commercial harvest in addition to the smaller diameter trees that may be killed during or after prescribed fire.

9.1.2 Stand Density (BA, TPA, SDI)

Changes to stand density from past, current, and foreseeable future actions continue to trend stands towards their historical range of variability. Many of the past regeneration harvests in the project area have been precommercially thinned to keep trees growing with less competition in order to grow larger trees at a faster rate. Stands on state and private land are being managed for density levels that keep their trees growing, usually for timber production. Proposed treatments would also keep residual trees growing across 9,010 acres. The cumulative effect is that past, current, and future projects have been implemented and designed to keep approximately 15,000 acres thinned to allow a steady and continual growth rate over time.

9.1.3 Mortality

Commercial thinning treatments, pre-commercial thinning treatments, and prescribed fire would all cumulatively reduce the impacts from potential stand-replacing disturbance on up to one-third of the project area. Actions across all ownerships would increase the initial volume loss through the direct harvest of trees on approximately 17,000 acres within these watersheds within the past 60 years and the foreseeable future. Volume gains continue to rise over the long-term across all ownerships while volume loss is minimized with past, current, and future actions. High intensity, high severity wildfire would be minimized, thus decreasing overall tree mortality across the landscape if these treatments act as barriers and aid in fire suppression. More growing space due to thinning would provide light and nutrients for remaining trees to increase crown ratio and diameter growth.

Fuels Treatments

Planned fuels treatments in the Ione Project Area include up to 1,095 acres of Natural Hazard Fuels reduction mainly utilizing underburning and up to 7,880 acres of Activities Fuels reduction (1-2 years post-harvest) utilizing piling, burning, and mastication. These projects are intended to have a net positive landscape level effect on resiliency to fire by decreasing fire hazard and treating FRCC 2 and 3 rated areas. These projects would reduce the risk to firefighters and the public and provide more strategic options for fire managers to manage wildfire on a larger scale. Since 1975, there has been 811 acres of underburning and 1,032 acres of slash piles burned. Most fuels treatments in this area were completed before 1997. These previous treatments will add more effectiveness to the planned treatments. There are no known fuels treatments on state or private lands.

9.1.4 Wildland Urban Interface (WUI)

Vegetation treatments throughout the identified WUI zones would contribute to long term (10+ years) reduction in uncharacteristic wildfire severity. As WUI continues to expand further into previously undeveloped areas, the previous, current, and future vegetation treatments result in the continued maintenance of these areas would become more crucial to firefighting success over the next 20-30 years.

9.1.5 Air Quality

Smoke from Hazardous Fuel and Commercial Harvest Activity Fuel burning may temporarily degrade air quality within the Ione analysis area and surrounding Pend Oreille River valley (where smoke tends to gather and accumulate). Coordinated meteorological scheduling would be used to regulate all prescribed burns within the regional area, thus minimizing the potential for cumulative smoke impacts to the public. Prescribed burns would be scheduled and approved by the WA DNR only during periods of favorable atmospheric transport and dispersion. To ensure compliance with state and federal air quality standards, approved burning would be determined through monitoring and computer modeling of all scheduled and proposed emissions. This includes proposed burns from state, private and federal ownerships.

9.1.6 Forest Health and Resiliency to Wildfire

All past and proposed vegetation treatments in this project would affect forest health fire resiliency of stands within the project area. Past and proposed actions in this area cumulatively increase the persistence of fire tolerant vegetation and would help maintain ecosystem function in the face of characteristic wildfire in the project area.

9.1.7 Firefighter and Public Safety

Improved access through the improvement and maintenance of forest system roads and more open stand conditions created by commercial harvest and prescribed burning will lead to improved long-term access (10 or more years). Previous and planned road maintenance in the project would allow for improved access by firefighting resources. Openings created through past USFS, DNR, private timber harvest, and underburning also may act as access routes for equipment including heavy machinery and aerial firefighting resources leading to more efficient suppression of wildfires. The additional acres in the Proposed Action would further increase access for firefighting resources.

9.1.8 *Fire Regime Condition Class (FRCC)*

All proposed vegetation treatments in the Ione Project Area will contribute to a shift from FRCC 2 and 3 (Severe/Moderate Departure) towards an FRCC 1 (Low/No Departure). Although there has been treatment accomplished in the project area, it was not of large enough size or broad enough scope to alter the FRCC in the analysis area.

10.0 Summary

10.1 Degree to Which the Purpose and Need for Action is Met

Table 17 shows that the proposed action would meet the purpose and need for the project.

10.1.1 *Forest Structure*

Treatments would meet the purpose and need by moving stands towards the HRV by vegetation type over time. In the short-term, many mid closed stands would be treated to move forest structure towards HRV. Some late closed stands that are within HRV would be treated to move stands into other forest structures, some of which are deficient across the landscape. In the long-term, forest structure is expected to also change due to insects, disease, and wildfire, but to a lesser degree with proposed activities. Without proposed activities, shade tolerant species would continue to establish on all sites where they take advantage of low light conditions and resources.

10.1.2 *Stand Density (BA, TPA, SDI)*

Treatments meet the purpose and need by keeping stands thinned to increase resiliency and resistance to disturbance agents over time. Proposed activities would reduce stand densities and maintain densities in which trees are free to grow (increases tree vigor) and where competition for resources is minimized. The effects of treatments on stand density begin to obscure over the long-term without maintenance activities, in comparison with no treatments. This is because trees continue to grow in thinned areas and created openings. However, species composition is changed through thinning. Basal area, trees per acre, and stand density index would all immediately reduce following proposed treatments. These metrics would steadily increase over time unless a future harvest, prescribed burning, or natural disturbances affect these areas. Thinning would reduce the effects of disturbance (insects, disease, and fire) by also selecting species suited to the appropriate vegetation type and site.

10.1.3 *Mortality*

Treatments would meet the purpose and need by reducing stand densities, changing species composition, and allocating more growing space over time. Effects from disturbance would be minimized, but not eliminated. Volume gain would remain at higher levels than volume loss over the projection period (now to the year 2058). However, by 2058, volume loss begins to increase without maintenance treatments. Volume loss generally remains lower than 20 percent of volume gain until 208.

Table 17. Comparison of metrics by alternative

Purpose and Need	Resource Indicator	Measure	No Action 2058	Proposed Action 2058
Reduce stand densities	Basal Area (BA)	ft^2/ac	216 – 320 ft^2 260 ft^2 avg	96 – 309 ft^2 137 ft^2 avg
Reduce stand densities	Trees per Acres (TPA)	trees per acre	264 – 653 458 avg	682 – 1209 935 avg

Purpose and Need	Resource Indicator	Measure	No Action 2058	Proposed Action 2058
Reduce stand densities	SDI	SDI units	421 - 527 467 avg	265 – 379 332 avg
Forest Health	Mortality	Volume growth per year accretion and mortality	Accretion: 123 Mortality: 56	Accretion: 95 Mortality: 17

10.2 Compliance with LMP and Other Relevant Laws, Regulations, Policies and Plans

All actions and mitigations follow required law, regulation, policy and plans.

This project is consistent with the LMP through the application of Standards and Guidelines and project design to meet the Desired Future Conditions as described in the LMP.

Fuels reduction activities would be consistent with the Clean Air Act through compliance with Regional, Federal, State, and Tribal air pollution regulations and coordinating activities with Washington State Smoke Management.

The National Forest Management Act, Clean Water Act, Clean Air Act, and Multiple-Use Sustained Yield Act all provide direction on how to plan and execute actions on federal lands appropriately. All site-specific project development (i.e. design features, mitigation measures, timing of project activities, etc.) followed guidance of these laws.

10.3 Other Relevant Mandatory Disclosures

10.3.1 Intensity Factors for Significance (FONSI)

The project area is 20,435 acres in size and covers portions of the Sweet Creek and Big Muddy Creek watersheds. The Sweet Creek watershed is approximately 41,800 acres and the Big Muddy Creek watershed is approximately 17,700 acres. Vegetation treatments would be implemented on a portion of the 18,864 acres of NFS land within this analysis boundary. The rest of the area, approximately 1,571 acres (8 %), are privately-owned. Commercial harvest is planned for approximately 7,880 acres. Noncommercial harvest is planned on many of those same 7,880 acres, with approximately 1,730 additional acres (outside of those 7,880 acres) for precommercial thinning.

Much of the NFS land within this project area is contiguous, aside from some checkerboard ownership with Washington State DNR and Private Industrial land.

There are many benefits to commercial thinning including, but not limited to: increased tree growth, selection of genetically superior trees, increased growing space, nutrients, and available water for growth of new cohorts of seedlings, and decreased susceptibility to disturbance agents. However, adverse impacts could occur in the short-term. These impacts could be loss of canopy cover, successional stage set-back, and changes in structure. The long-term benefits outweigh the short-term impacts, especially given the spatial scale of proposed actions. Proposed actions only affect a localized area (watershed) within the larger landscape. These effects generally last anywhere from 10 to 30 or 40 years, depending on the intensity of thinning.

Public health and safety is always a concern when implementing projects on national forest administered lands. Mitigation measures to avoid conflicts during peak recreation season would be followed. These may include restricted log-hauling around campgrounds during certain hours or days of the week.

11.0 References Cited

Agee, J. K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Washington DC.

Agee, J.K. 1996. The influence of Forest Structure on Fire Behavior. 17th Annual Forest Vegetation Management Conference, Redding, Ca January 16-18, 1996.

Agee, James K. 2003. Historical range of variability in eastern Cascades forests, Washington, USA.

Anderson, Hal E. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. GTR INT-122. Intermountain Research Station. Ogden, UT 84401

Arno, S.F. and D.H. Davis. 1980. Fire History of Western Redcedar/Hemlock Forests in Northern Idaho. In: Proceedings of the Fire History Workshop; 1980 October 20-24; Tucson AZ. Gen. Tech. Rep. RM-81 Fort Collins, CO. USDA-FS. Rocky Mountain Experiment Station.

Barrett, S.W. and S.F. Arno. 1991. Classifying Fire Regimes and Defining Their Topographic Controls in the Selway-Bitterroot Wilderness. In Proceedings of the 11th Conference on Fire and Forest Meteorology; 1991 April Missoula MT. Bethesda, MD: Society of American Foresters; 299-307.

Barrett, S.W. 1982. Fires Influence on Ecosystems of the Clearwater National Forest: Cook Mountain Fire History Inventory. Orofino, ID: USDA-FS Clearwater National Forest.

Bradley, C.M., Hanson, C.T., DellaSala, D.A. 2016. Does increased forest protection correspond to higher fire severity in frequent fire-prone forests of the western United States? Ecological Society of America.

Brown, J.K. 1995. Fire regimes and their relevance to ecosystem management. Pages 171-178 In Proceedings of Society of American Foresters National Convention, Sept. 18-22, 1994, Anchorage, AK. Society of American Foresters, Wash. DC.

Brown, James K.; Smith, Jane Kapler, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 p.

Campbell, S. and L. Liegel. 1996. Disturbance and Forest Health on Oregon and Washington. USDA Forest Service PNW Research Station Gen Tech Rpt PNW-GTR-381.

Carlson, E. and W.N. Wulf. 1989. Silvicultural Strategies to Reduce Stand and Forest Susceptibility to the Western Spruce Budworm. USDA-FS Ag Handbook No. 676

Chance, David H. 1991. The Lumber Industry of Washington’s Pend Oreille Valley 1888-1941.USDA-FS Contract 43-05G1-0-4600, Colville National Forest.

Charnley, S., Spies, T.A., Barros, A.M., White, E.M., Olsen, K.A. 2017. Diversity in forest management to reduce wildfire losses: implications for resilience. Ecology and Society 22(1):22

Churchill, Derek. 2011. Draft Colville National Forest, Mesic Forest Ecology and Management. Unpublished.

Cochran, P.H., J.M. Geist, D.L. Clemens, R.R. Clausnitzer, and D.C. Powell, D.C. 1994 Suggested Stocking Levels for Forest Stands in Northeastern Oregon and Southeastern Washington. Gen. Tech. Rep. PNW-RN-513. Portland, Oregon.

Cochran, P.H et al. 1994. Suggested Stocking Levels for Forest Stands in Northeastern Oregon and Southeastern Washington. USDA Forest Service, Pacific Northwest Research Station Research Note PNW-RN-513.

Cohen, Jack U. and Butler, Bret W. 1999. *Modeling potential ignitions from flame radiation exposure with implications for wildland/urban interface fire management*. In: Proceedings of the 13th conference on fire and forest meteorology; 1996 October 27-31; Lorne, Victoria, Australia. Fairfield, WA: International Association of Wildland Fire.

Cohen, Jack. 1999. *Reducing the Wildland Fire Threat to Homes: Where and How Much?* USDA Forest Service Gen. Tech. Rep. PSW-GTR-173. 6 p. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Fort Collins, Colorado.

Colville National Forest Land Management Plan (LMP). 2019. USDA Forest Service, Colville, WA.

DeBano, Leonard F., Daniel G. Neary, Peter F. Folliott. 1998. Fire Effects on Ecosystem. Hohn Wiley and Sons, Inc. New York. 332pp.

DeLuca, T.H. and Sala, A. (2006) Frequent Fire Alters Nitrogen Transformations in Ponderosa Pine Stands of the Inland Northwest. Ecology 87: 2511-2522.

Devlin, Robert J. 1998. (Letter) Screen Review, Colville National Forest, USDA-FS

Devlin, Robert J. 1999. (Letter) Screen Questions, Consideration of Private Land, USDA-FS

DeWald, L.E. and M.F. Mahalovich. 1997. The Role of Forest Genetics in Managing Ecosystems. Journal of Forestry, April 1997, Volume 95, Number 4

Dickman, A. and S. Cook. 1989. Fire and fungus in a mountain hemlock forest. Canadian Journal of Botany. 67(7): 2005-2016

Dixon, G.E. 2018. Essential FVS: A User’s Guide to the Forest Vegetation Simulator. USDA Forest Service, Forest Management Service Center. Fort Collins, CO

Drew, T.J. and J.W. Flewelling. 1977. Some Japanese theories of yield-density relationships and their application to Monterey pine plantations. For. Sci. 23: 517- 534.

Dunning, D. L. and L.H. Reineke. 1933. Preliminary yield tables for second growth stands in the California pine region. USDA Tech. Bulletin No. 354. 23 pgs.

Edmonds, R.L., J.K. Agee, and R.L. Gara. 2000. Forest Health and Protection. Waveland Press, Long Grove IL.

Fire Regime Condition Class Definition. 06/23/2003 www.nifc.gov.

Finney, M.A.; McHugh, C.W.; Grenfell, I.C. 2005. Stand-and landscape-level effects of prescribed burning on two Arizona wildfires. Canadian Journal Forest Resources 35: 1714-1722p

Fischer, William C. 1981. Photo Guide for Appraising Downed Woody Fuels in Montana Forests. GTR INT 96, 97. Ogden, Ut, USDA-FS, Intermountain Forest and Range Station.

Franklin, J.F., R.J. Mitchell, P.J. Palik. 2007. Natural Disturbance and Stand Development Principles for Ecological Forestry. USDA-FS Northern Research Station GTR NRS-19.

Graham, Russell T., A.E. Harvey, T.B. Jain, and J.R. Tonn. 1999. The effects of thinning and similar stand treatments on fire behavior in Western forests. Gen. Tech. Rep. PNW-GTR-463. Portland, Or: USDA, Forest Service, Pacific Northwest Research Station.

Graham, Russell T., S. McCaffrey, and T.B. Jain. 2004. Science basis for changing forest structure to modify wildfire behavior and severity. Gen. Tech. Rep. RMRS-GTR-120. Fort Collins, Co. USDA Forest Service, Rocky Mountain Research Station.

Hadfield, Jim. 1995. (Letter) Insect and Disease Conditions Totem Planning Area. USDA-FS Eastern Washington Forest Health Office. Wenatchee National Forest. Wenatchee, WA.

Hadfield, Jim. 1999. (Letter) *Armillaria* Root Rot in the Wolfman Timber Sale Area. USDA-FS Eastern Washington Forest Health Office. Wenatchee National Forest. Wenatchee, WA.

Hadfield, J. and D. Carlson. 2007. (Letter) Summit Pierre Fuels Planning Area, Disease and Insect Assessment. USDA-FS Eastern Washington Forest Health Office. Wenatchee National Forest. Wenatchee, WA.

Hagle, S.K. and G.I. McDonald. 1989. White pine blister rust in northern Idaho and Montana: Alternatives for integrated management. Gen Tech Rpt. INT 261. Ogden, UT. USDA Forest Service, Intermountain Research Station

Hagan, W.T. and K.L. O'Hara. 2001. Height:diameter ratios and stability relationships for four Northern Rocky Mountain tree species. WJAF 16(2)

Hann, W.J., Bunnell, D.L. 2001. Fire and land management planning and implementation across multiple scales. Int. J. Wildland Fire. 10:389-403.

Helms, J.A.1998. The Dictionary of Forestry. Society of American Foresters, Bethesda, MD.

Hemphill, Stephanie, 2008. Study: *Removing Biomass from Forests Does No Harm and Prevents Fires.* Minnesota Public Radio. Available at: www.minnesota.publicradio.org/display/web/2008/06/19/biomass study/ (accessed December 2009).

Hessburg, P.F., R.G. Mitchell, and G.M. Filip. 1994 Historical and Current Roles of Insects and Pathogens in Eastern Oregon and Washington Forested Landscapes. UDSA-FS PNW Research Station, Gen Tech Rpt 327, April 1994

Hessburg, P.F., J.K. Agee, and J.F. Franklin. 2005. Dry forests and wildland fires of the inland Northwest USA: Contrasting the landscape ecology of the pre-settlement and modern eras. Forest Ecology and Management 211, 117-139.

Hessburg, P.F., D.J. Churchill, A.J. Larson, R.D. Haugo, C. Miller, T.A. Spies, M.P. North, N.A. Povak, R.T. Belote, P.H. Singleton, W.L. Gaines, R.E. Keane, G.H. Aplet, S.L. Stephens, P. Morgan, P.A. Bisson, B.E. Reiman, B. Salter, and G.H. Reeves. 2015. Restoring fire prone Inland Pacific landscapes: seven core principles. Landscape Ecology, 30:1805-1835

Hicks, Brian 2010. Fire, Fuels, and Air Quality Report for the Power Lake Timber and Fuels Management Project Environmental Assessment Report. 30 pages.

Hood, S. and B. Bentz. 2007. Predicting postfire Douglas-fir beetle attacks and tree mortality in the Northern Rocky Mountains. Can. J. For. 37: 1058-1069.

Huff, M.H., R.D. Ottmar, E. Alvarado, R.E. Vihnanek, J.F. Lehmkuhl, P.F. Hessburg, and R.L. Everett. 1995. *Historical and Current Forest Landscapes in Eastern Oregon and Washington. Part II: Linking Vegetation Characteristics to Potential Fire Behavior and Related Smoke Production.* General Technical Report. PNW-GTR-355, USDA Forest Service Pacific NW Research Station, Portland, Oregon. Available online; http://www.fs.fed.us/pnw/pubs/gtr355/gtr355a.pdf [3 May 2004].

Huggett, Robert J., K.L. Abt, and W. Shepperd. 2008. *Efficacy of mechanical fuel treatments for reducing wildfire hazard.* Forest Policy and Economics 10 (2008) 408-414. Elsevier B.V. Available online: www.elsevier.com/locate/forpol

Idaho Department of Environmental Quality 2010. Available online: http://www.deq.idah.gov/air/prog_issues/pollutants/health.cfm#criteria

Johnson, C.G., R.R. Clausnitzer, P.J. Mehringer, and C.D. Oliver. 1994. Biotic and abioticprocesses in eastside ecosystems: the effects of management on plant and community ecology and on stand and landscape vegetation dynamics. USDA Forest Service. PNW-GTR322. pp. 93-217.

Johnson, K., F.J.F. Norman. 2007. Forest Restoration and Hazardous Fuels Reduction Efforts in the Forests of Oregon and Washington Testimony. Hearing of Subcommittee on Public Lands and Forests of the Senate Committee on Energy and Natural Resources. December 13, 2007.

Kegley, S., C. Randall, D. Jewett, and Wulff. 1999. Douglas-fir Beetle Population Surveys ,Idaho Panhandle National Forests, 1998. USDA Forest Service, Region 1, Rpt. No. 99-5.

Kegley, S. 2000. Douglas-fir Beetle Population Assessment, Idaho Panhandle National Forests. USDA Forest Service, Region 1, Missoula, Mt., March 2000

Koch, P. 1996. Lodgepole Pine Commercial Forests: an Essay Comparing the NaturalCycle of Insect Kill and Subsequent Wildfire With Management for Utilization and Wildlife. USDA-FS Intermountain Research Station, Gen Tech Rpt INT-GTR-342.

Krist, F.J., Ellenwood, J.R., McMahan, A.J., Cowardin, J.P., Ryerson, D.E., Saplo, F.J., Zwelfler, M.O., Romero, S.A. 2014. 2013-2027 National Insect and Disease Forest Risk Assessment. USDA Forest Service Forest Health Technology Enterprise Team. FHTET-14-01.

Landfire Imagery. 2007. Landscape Fire and Resource Management Planning Tools Project. Missoula Fire Sciences Laboratory, Missoula, MT 59807. Available online: http://www.landfire.gov

LANDFIRE 2014. USDI U.S. Geological Survey.

Louks, B. 2001. Air Quality PM 10 Air Quality Monitoring Point Source Emissions; Point site locations of DEQ/EPA Air monitoring locations with Monitoring type and Pollutant. Washington Department of Environmental Quality. Feb. 2001. As GIS Data set. Boise, Id.

Morgan, P., S. C. Bunting, A. E. Black, T. Merrill, and S. Barrett. 1996. Fire regimes in the interior Columbia River basin: past and present. Report on file at USDA Forest Service Intermountain Fire Sciences Laboratory, Rocky Mountain Research Station, Missoula, MT.

Morgan, P. 2016. Climate, Forests, and Fire. Webinar. University of Idaho. January 7, 2016.

NWCG, Interagency Prescribed Fire Planning and Implementation Procedures Guide. PMS 484. July 2017 https://www.nwcg.gov/sites/default/files/publications/pms484.pdf

National Forest Management Act of 1976 (NFMA). 1976. (16 U.S.C. 1600). National Environmental Policy Act (NEPA). 1970. (42 U.S.C 4321-4370h).Omi, Philip N., Martinson, Erik J. 2002. Effectiveness of thinning and prescribed fire in reducing wildfire severity. Western Forest Fire Research Center, Colorado State University. Presented at Sierra Nevada Science Symposium, October 7-9, 2002, North Lake Tahoe, CA

National Interagency Fuels, Fire and Vegetation Technology Transfer. September 2010. Interagency Fire Regime Condition Class (FRCC) Guidebook Ver. 3.0 https://www.landfire.gov/frcc/documents/FRCC_Guidebook_2010_final.pdf

Office of the Federal Register National Archives and Records Administration, 1997. Code of Federal Regulations. US Govt Printing Office. Washington

O'Laughlin, J. and Cook, P.S. 2003. Inventory-Based Forest Health Indicators: Implications for National Forest Management. Journal of Forestry. March 2003,

Omi, P.N. and E.J. Martinson. 2009. Effectiveness of Fuel Treatments for Mitigating Wildfire Severity: A Manager-focused Review and Synthesis. Joint Fire Science Project# 08-2-1-09

Ottmar. R.D. 2001. Smoke source characteristics. Pgs 89-105 in *Smoke Management Guide for Prescribed and Wildland Fire. 2001 Edition.* C.C. Hardy, R.D. Ottmar, J.L. Peterson, J.E. Core, and P. Seamon, eds. National Wildlife Coordination Group. PMS 420-2. Available online; http://www.nwcg.gov/pms/pubs/SMG-72.pdf [10 December 2003].

Pollet, Jolie and Omi, Philip N. 1999 Effects of Thinning and Prescribed Burning on Wildfire Severity in Ponderosa Pine Forest. 5pp.

Rothermel, R. C. 1972 A mathematical model for predicting fire spread in wildland fuels. Res. Pap. INT-115. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 40 p.

Rothermel, Richard C. 1983 How to Predict the Spread and Intensity of Forest and Range Fires. USDA Forest Service, Intermountain Forest and Range Experiment Station. Ogden, UT. Research Paper INT-143

Rothermel, Richard C. 1991. Predicting Behavior and Size of Crown Fires in the Northern Rocky Mountains. USDA Forest Service, intermountain Research Station. Ogden, UT. Research Paper INT-438. 46pp

Schellhaas, R., D. Spurbeck, D. Olson, P., A.E. Camp, and D. Keenum. 2000. Report to the Colville National Forest on the results of the South Deep Watershed fire history research. Available from: Wenatchee Forestry Sciences Laboratory, Pacific Northwest Research Station, 1133 N. Western Ave., Wenatchee WA, 98801.

Schlosser, W. E., T. R. Brown, and T. R. King. Lead Authors. 2005 Pend Oreille County, Washington. Community Wildfire Protection Plan. Northwest Management, Inc., Moscow, Idaho. November 21, 2005 Pp. 189.

Schmidt, K.M., Menakis, J.P. Hardy, C.C., Hann, W.J., Bunnell, D.L. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. General Technical Report, RMRS-GTR-87, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Scott, Joe H. and Elizabeth D. Reinhardt. 2001. Assessing crown fire potential by linking models of surface and crown fire behavior. RMRS-RP-29. Fort Collins, CO. USDA Forest Service, Rocky Mtn. Research Station. 59 pages.

Scott, Joe H. 2006 Comparison of Crown Fire Modeling Systems Used in Three Fire Management Applications. RMRS-RP-58. Fort Collins, CO. USDA Forest Service Rocky Mtn. Research Station. 29 pages

Smith, Jane Kapler; Fischer, William C. 1997. Fire Ecology of the Forest Habitat Types of Northern Idaho. Ogden, UT; U.S. Department of Agriculture, Forest Service, Intermountain Research Station. Gen. Tech. Rep. INT-GTR-363. 142 pp.

Stephens, Scott L. and Lawrence W. Ruth. 2005. Federal forest-fire policy in the United States. Ecological Applications, 15(c), 2005. pp. 532-542.

Stratton, Richard D. 2006 Guidance on Spatial Wildland Fire Analysis: Models, Tools, and Techniques.

Stine, P., Hessburg, P., Spies, T., Kramer, M., Fettig, C.J., Hansen, A., Lehmkuhl, J., O'Hara, K., Polivka, K., Singleton, P., Charnley, S., Merschel, A., White, R. 2016. The ecology and management of moist mixed-conifer forests in eastern Oregon and Washington: a synthesis of the relevant biophysical science and implications for future land management. USDA Forest Service, Gen. Tech. Re. PNW-GTR-897. Portland OR.

Stone, C., Hudak, A., Morgan, P. 2008. Forest Harvest Can Increase Subsequent Forest Fire Severity. Proceedings of the Second International Symposium on Fire Economics, Planning, and Policy: A Global View. USDA Forest Service, Pacific Southwest Research Station, PSW-GTR-208. Albany CA

Tappeiner, J.C., D.A. Maguire, and T.B. Harrington. 2007. Silviculture and Ecology of Western Forests. Oregon State University Press, Corvallis OR.

Trimble, Eric 2009. Hanlon Fire and Fuels Report. USDA. Colville National Forest. 18 p.

USDA. 1995. Inland Native Fish Strategy (Decision Notice and Environmental Assessment). Coeur D'Alene, ID.

USDA FS. 1993. Colville National Forest Memo 1950/2410. Subject: Old Growth Definitions. Colville, WA.

USDA USFS. 2000 Incorporating Air Quality Effects of Wildland Fire Management into Forest Plan Revisions – A Desk Guide. April 2000

USDA Newport/Sullivan Lake RD's, Colville National Forest - Firemon post-burn monitoring report – Unpublished document quantifying the vegetative and soil effects of prescribed burns conducted between 2003 and 2010.

USDA, USDI. 2003. Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy 57 pp.

USDA FS. USDI, BLM. 2004. The Healthy Forests Initiative and Healthy Forests Restoration Act:
Interim Field Guide. FS-799. Washington, DC.

USDA, USDI. 2009. Guidance for Implementation of Federal Wildland Fire Management Policy. 20 pgs. Graham, R.T., Aland E. Harvey, Theresa B. Jain, Honalea R. Tonn. 1999. The Effects of Thinning and Similar Stands Treatments on Fire Behavior in the Western Forest. USDA Forest Service, Pacific Northwest Research Station. PNW GTR-463. 28pp

Van Wagner, C. E. 1977 Conditions for the start and spread of crown fire. Canadian Journal of Forest Research 7:00 23-34.

Van Wagtendonk, J.W. 1996. Use of a deterministic Fire Model to Test Fuel Treatments in Sierra Nevada Ecosystem Project: Final Report to Congress. Vol. 2. Davis, CA: University of California, Davis, Center for Water and Wildland Resources: 1155-1167.

Washington Dept. of Natural Resources. 1993 (revised 1998). Smoke Management Plan. Olympia, WA.

Washington Forest Practice Board (WFPB). 2001. Forest Practice Act RCW 76.09. WA DNR

Wickman, B.E., R.R. Mason, T.W. Swetnam. 1993. Searching for long-term patterns of forest insect outbreaks. In: Individuals, populations, and patterns: Proceedings of a meeting; 1992 September 7-10; Norwich, England.

Williams, C.K., T.R. Lillybridge, and B.G. Smith. 1990, 1995. Forested Plant Associations of the Colville National Forest.

Appendix A

Proposed Action Commercial and Noncommercial Treatment Unit Attributes

Unit	Logging System	Commercial Silviculture Method (Map Legend)	Noncommercial Activities (Map Legend)	Potential Silviculture Prescription, showing combination treatments	Vegetation Type	Acres	Structure Stage
1	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	63	3
2	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry/Rocky Mtn	57	3
3	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	196	3
4	Tractor	Shelterwood	Pile Logging Slash	HSH/HTH	Mix	118	3
5	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	92	3
6	Tractor	Shelterwood	Pile Logging Slash	HSH/HTH	Mix	81	3
7	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	160	3
8	Skyline	Commercial Thin	No Fuels Treatment	HTH	Rocky Mtn/RC-WH	59	3
9	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	107	3
10	Tractor	Shelterwood	Pile Logging Slash	HSH/HTH	Mix	120	3
11	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry/Rocky Mtn	38	3,5
12	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	42	3
13	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	66	3
14	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	13	3
15	Tractor	Commercial Thin	Pile Logging Slash	HTH	RC-WH	25	3,5
16	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	41	3
17	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry	12	3
18	Skyline	Shelterwood	No Fuels Treatment	HSH	DF-dry	89	3
19	Tractor	Shelterwood	Pile Logging Slash	HSH/HTH	DF-dry	85	3
20	Tractor	Shelterwood	Pile Logging Slash	HSH/HTH	DF-dry	82	3
21	Tractor	Shelterwood	Pile Logging Slash	HSH	DF-dry/Rocky Mtn	261	3
22	PCT	n/a	Precommercial Thin	PCT	RC-WH	21	1,3
23	Tractor	Shelterwood	Pile Logging Slash	HSH	DF-dry/Rocky Mtn	37	3
24	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry/Rocky Mtn	157	3
25	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry	100	3
26	Mechanical	n/a	Mastication	MASTICATE	DF-dry	516	3
27	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry/Rocky Mtn	54	3
28	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry	106	3
30	Tractor	Shelterwood	Underburn within Harvest Units	HSH/HTH	DF-dry/Rocky Mtn	69	3
31	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry/Rocky Mtn	63	3
32	Tractor	Commercial Thin	Underburn within Harvest Units	HTH/PCT	DF-dry	13	3
33	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry	14	3
34	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry/Rocky Mtn	134	3
35	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry/Rocky Mtn	89	3
36	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	Rocky Mtn/RC-WH	45	3,5
37	Tractor	Shelterwood	Underburn within Harvest Units	HSH/HTH	DF-dry	148	3
38	Tractor	Shelterwood	Underburn within Harvest Units	HSH/HTH	DF-dry	160	3
39	Tractor	Commercial Thin	Underburn within Harvest Units	HTH/HSG	DF-dry/Rocky Mtn	110	3
40	Tractor	Shelterwood	Underburn within Harvest Units	HSH/HTH	Rocky Mtn	113	3
41	Tractor	Shelterwood	Underburn within Harvest Units	HSH/HTH	Rocky Mtn	283	3
42	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	Rocky Mtn	80	3
43	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry/Rocky Mtn	70	3
44	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	Rocky Mtn	101	3
45	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	DF-dry	159	3
46	Mechanical	n/a	Mastication	MASTICATE	DF-dry	136	3
48	Tractor	Shelterwood	Underburn within Harvest Units	HSH/HTH	DF-dry/Rocky Mtn	259	3
49	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	Rocky Mtn	79	3,5
50	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry/Rocky Mtn	76	3,5
51	Tractor	Shelterwood	Underburn within Harvest Units	HSH/HTH	DF-dry/Rocky Mtn	232	3
52	Tractor	Commercial Thin	Pile Logging Slash	HTH	DF-dry/Rocky Mtn	217	3
53	Tractor	Commercial Thin	Underburn within Harvest Units	HTH/HSG	Rocky Mtn	183	3
54	Tractor	Commercial Thin	Pile Logging Slash	HTH/HSH	DF-dry/Rocky Mtn	138	3
55	Tractor	Commercial Thin	Underburn within Harvest Units	HTH/HSG	Mix	82	3
57	Tractor	Shelterwood	Underburn within Harvest Units	HSH/HSG	DF-dry/Rocky Mtn	117	3
58	Tractor	Commercial Thin	Underburn within Harvest Units	HTH	Rocky Mtn	84	3
61	Tractor	Shelterwood	Pile Logging Slash	HSH	Rocky Mtn	97	3,5
63	Tractor	Shelterwood	Pile Logging Slash	HSH/HTH	Rocky Mtn	124	3
64	Tractor	Commercial Thin	Pile Logging Slash	HTH	Rocky Mtn	97	3
65	Tractor	Commercial Thin	Pile Logging Slash	HTH	Mix	114	3
66	Tractor	Shelterwood	Pile Logging Slash	HSH	Rocky Mtn/RC-WH	113	3
68	Tractor	Commercial Thin	Pile Logging Slash	HTH	Rocky Mtn/RC-WH	48	3,5
69	Tractor	Shelterwood	Pile Logging Slash	HSH/HTH	DF-dry/Rocky Mtn	153	3
70	Tractor	Commercial Thin	Underburn within Harvest Units	HTH/HSG	DF-dry/Rocky Mtn	263	3,5
71	Tractor	Commercial Thin	Underburn within Harvest Units	HTH/HSG	DF-dry/Rocky Mtn	190	3
72	RHCA	n/a	Large Woody Material Aquisition	RHCA	Rocky Mtn/RC-WH	15	5
73	Tractor	Commercial Thin	Pile Logging Slash	HTH	Mix	114	3
74	Tractor	Shelterwood	Pile Logging Slash	HSH	Rocky Mtn	14	3